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ABSTRACT

Suggested is a learning systems approach designed to be consistent with the objectives and scope of developmental psychology and yet sophisticated and appropriate enough to fit the unique demands of early childhood education. Identified are eight contingencies for learning that any educational system must possess. Added to these are features considered distinctive to learning environments for preschool children. Among these features are the family as a learning system, a systems perspective, a psycho-social theory of classroom learning, the philosophic position, criteria and specifications, the operational stage, evaluating and measuring learning systems, an educational research superstructure, and the educational research testing system. Eight figures specify designs and relationships important in conceptualizing and operationalizing this approach. (WY)

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DESIGNS AND PROPOSAL FOR EARLY CHILDHOOD RESEARCH: A NEW LOOK: A SYSTEMS APPROACH TO PRE-SCHOOL EDUCATION

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A Systems Approach to Pre-School Education

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INTRODUCTION

Education in crisis implies a society in peril. The gestational role of education as the key institution for providing manpower skills and social stability imposes a requirement for substantive educational change as a high ranking national priority.

It is imperative that we identify, select, and use those methods which predict and control the improvement of learning rate, retention, conceptual and performance skills as well as social and human values. This paper represents an effort to present one approach to the research on learning systems for pre-school children.

How and why behavior changes is basic to any educational approach. The improvability of human learning for education in the pre-school area is dominated by the Developmental-Maturational position. Considerable attention is now focused on behavioral specification and management of contingencies; this view is largely derived from B.F. Skinner's work and thinking and, therefore, will be termed The Skinnerian-Behavioral Position. Few analysts who have examined learning problems have limited themselves, absolutely, to one or the other position. However, for definitional purposes, the alternative positions will be stated in absolute terms.

The Absolute Maturational & Development Position

The maturational position, in its least sophisticated form, suggests a parallel between physical and intellectual growth. In both domains, the infant, largely controlled by genetic factors, is viewed as moving through successive stages, growing and

becoming more proficient over time. Cultural and environmental factors nurture and enrich both behavioral and physical growth, but are not the true determinants of personality, attitudes or intellectual capability. The child can attain only that level which was initially (genetically) possible. He moves through the successive stages of behavioral (and intellectual) development at a rate largely determined by his genetic potential. There is some modifiability but, except in extreme ranges of environmental pauperism and enrichment, environment is believed to have little substantive effect on ultimate performance level.

The Maturationist View

Rousseau in Emile saw the child as a two-stage learner: first imagery, then ideation. His views are cogently expressed in the following passages:

> ...Before the age of reason, the child does not receive ideas, but images; and there is this difference between the one and the other, that images are only absolute depictions of tangible objects, and that ideas are notions about objects, determined by certain relationships. An image can be alone in the mind which conceives it; but every idea presupposes others. When one imagines, one does nothing but see; when one conceives, one compares... (in Levitas, 1963; p.4).

His second view of the stages appears to equate sensation with imagery and suggests that, as ideation emerges, ancient images must be reordered:

> ...All their knowledge is in sensation; nothing has passed into the understanding. Their memory itself is hardly more perfect than the other faculties, since it is almost always necessary, when they are grown-up, that they learn again the things for which they learned the words in childhood... (Ibid.)

Piaget, using a more modern and formal idiom, (with such terms as reflexes, schemata, perceptions, etc.) has articulated

a position similar to Rousseau's but one considerably more detailed and elaborate. The following conveys the essence of his position:

> ...between the sensorimotor intelligence which precedes the advent of speech and the later practical intelligence which subsists under verbal and conceptual realities, there is not only a linear continuity but also there are temporal displacements in extension, so that in the presence of every truly new problem the same primitive processes of adaptation reappear, although diminishing in importance with age (Piaget, 1954; pp. 357-58).

Note that Piaget appears to reassess Rousseau's fundamental view that sensation--Piaget uses the term "sensorimotor intelligence"--precedes speech as well as the later "practical intelligence", that is, the development of skills in making adequate choices in daily life activities. However, the three stages (sensorimotor intelligence, speech and practical intelligency) are constantly recapitulated in situations where choices are not apparent and decision making skills must be learned. Piaget expresses this process of three stage ideational evolution in the following way:

> ...Thus it may be seen that thought in its various aspects reproduces on its own plane the process of evolution we have observed in the case of sensorimotor intelligence and the structure of the initial practical universe. The development of reason, outlined on the sensorimotor level, follows the same laws, once social life and reflective thought have been formed. Confronted by the obstacles which the advent of those new realities raises, at the beginning of this second period of intellectual evolution assimilation and accommodation again find themselves in a situation through which they had already passed on the lower plane. But in proceeding from the purely individual state characteristic of sensorimotor intelligence to the cooperation which defines the plane on which thought will move henceforth, the child, after having overcome his egocentrism and the other obstacles which impede this cooperation, receives from

> it the instruments necessary to extend the rational construction prepared during the first two years of life and to expand it into a system of logical relationships and adequate representations. (Ibid; pp. 385-86).

It may be worth noting that Piaget infers that the process of moving to the third "rational" stage involves a neo-Freudian conquest of egocentric obstacles. Only by overcoming infantilism, egocentrism and needs does the human infant move to the plane of rational thought. The initial stage of this victory occurs during the first two years of life. Piaget explains the process this way:

> ...Moreover, gradually as objects, causality, space and time are elaborated, a coherent universe follows the chaos of the initial egocentric perceptions. When in the second year of life representation completes action by means of the progressive internalization of behavior patterns, one might therefore expect that the totality of sensorimotor operations would merely pass from the plane of action to that of language and that the organization of schemata would thus be directly extended in a system of rational concepts. (Ibid; p.357).

A more radical maturational view is expressed by Arnold Gesell. Gesell considers the sequence and ordering of behaviors as evolving events in time, largely controlled by muscles, nervous system development, skeletal readiness, etc. The child's emerging behaviors are essentially manifestations of physical readiness to perform those tasks we observe. There is a natural and inevitable order of maturational unfolding:

> ...Every child is unique; but every child is also a member of one human species. Obedient to these species characteristics there are growth sequences which are rarely or never circumvented. The motor control of the eyes precedes that of the fingers; head balance precedes body balance; palmar prehension precedes digital prehension; voluntary grasp precedes voluntary

> release. Banging comes before poking; vertical and horizontal hand movements before circular and oblique; crawling before creeping; creeping before upright walking; gestures before words; jargon before speech; nouns before prepositions; solitary play before social; perceptions before abstractions; practical before conceptual judgments. These are but a few simple examples of the sequential order inherent in the structuralization of child behavior, from its lowest to its highest manifestations. (Gesell, 1949, pp.21-22.)

Gesell sees behavior as having definite points of maturation which erupt, much like a baby tooth, when the pre-existing behavioral or perceptual building blocks have manifested themselves into the necessary substructure to support new behavioral manifestation. The skills for building a tower of blocks is viewed this way:

> ...The final pattern of tower building is a condense culmination of all the growth that went before. The gradient begins with the comparatively simple pattern of looking. With increasing maturity one refinement follows another in lawful sequence: 1. Ocular focus 2. Arm approach 3. Manual grasp 4. Finger grasp 5. Release 6. Tower. At 15 months the infant unreels this sequence in a flash, but this skillful flash of behavior is the patterned end-product of a whole year of constructive growth! (Ibid.)

Reading is viewed in similar terms:

> ...All school skills have a similar pre-history of growth. They are always subject to the principle of developmental readiness. They are never the sole product of training or drill. For example, consider another simple six step gradient in the field of Reading Behavior. The 15-month old child who has just attained the sensorimotor skill of building a tower is also at the lower threshold of reading. He can already help to turn the pages of a

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picture book. He can definitely identify the circular hole in a circle-triangle-square form board. Surely this is the growth rudiment of the capacity to recognize the round letter 0, which is the beginning of all reading! Moreover he can read some of the pictures of a book to this extent: He pats a picture which he recognizes. Our illustrative growth gradient begins with that pattern of behavior, - an elementary perception of a picture on the printed page.

Reading Behavior

1)	15 months	Pats identified picture in book.
2)	18 months	Points to an identified picture in book.
3)	2 years	Names 3 pictures in book.
4)	3 years	Identifies 4 printed geometric forms.
5)	4 years	Recognizes salient capital letters.
6)	5-6 years	Recognizes salient printed words (Ibid).

However, beneath these apparent cumulative building processes which combine to provide maturational readiness, Gesell sees another deeper pattern -- a genetic determinism. He unambiguously expresses his conviction that personality patterns and learning abilities are likewise woven into the maturational web and woof of life. The limits are quite inflexible; in fact, the infant is largely "determined" at birth:

> ...Long range studies made in our clinic have demonstrated that such traits as social responsiveness, readiness of smiling, self-dependence and motor agility tend to manifest themselves and to persist under varying environmental conditions. Every child is born with a 'natural' which colors and structures his experiences. The infant, to be sure, has great plasticity, great powers of learning; but there are lawful limits to his conditionability. He has constitutional traits and tendencies, largely inborn, which determine how, what, and to some extent even when he will learn. (Ibid; Section I, pp.40-41).

In Gesell's teleological argument, both behavioral traits and anatomy are inevitably determined by the seed. In man, as in

trees, the first moment of conception predestines most of the rest:

> ...These traits are both racial and familial. The racial traits are those which are common to the whole human species. The familial traits are the distinctive endowment which he inherited from his parents and a long line of grandparents. The child comes into this double inheritance through an innate process of growth which we call maturation. He comes into the social 'heritage' of culture, through a process of acculturation. These two processes interact and interfuse, but the process of maturation is most fundamental, - so fundamental that acculturation can never transcend maturation. (Ibid.)

This ultimate position -- that behavior is an inevitable unfolding of "racial and familial endowment" -- places Gesell in a theoretical cul-de-sac. His psychology ultimately is reduced to tape, film and written recordings of events long predestined. In his hands psychological intervention becomes an absurdity because all behavior has been pre-printed in the chromosomal gel. Each individual in turn is merely a combined reflection of two predestined chromosome pairs who had joined inevitably, as had all generations of chromosomes before them.

Despite Gesell's fundamentalist view on maturation, his work reveals many ingenious devices which could serve to improve the rate of development of those children he studied. His laboratory techniques provided enrichment through novel and artful toys, activities, social and verbal interaction, sympathetic interest, and a sophisticated and empathetic research staff. Thus the actuality of Gesell's work involved the testing of developmental processes within an enriched environment. What would have occurred through maturation alone is left untested in a laboratory sense, although Gesell makes his own faith clear enough.

Thus, Gesell, perhaps inadvertently, approached the developmental position which differs from the maturational in its freedom from genetic determinism, its faith in the effects of enrichment, and its emphasis on research methods rather than observation and

recording. Modern developmental psychology, though eclectic and uncommitted to any rigorous theoretical camp, holds that much can be done to improve human learning, performance, social interaction and the educational process.

The Developmental Position

The zoologist-geneticist, Julian Huxley, whom one might expect would hold a strong genetic determinist view, speaks vigorously for the unlimited growth potential of the individual and humanity:

> ...The critical point in the evolution of man- the change of state when wholly new properties emerged in evolving life- was when he acquired the use of verbal concepts and could organize his experience in a common pool. It was this which made human life different from that of all other organisms; and we can now begin to grasp the nature of profundity of the difference. The development of animals is always closed; their evolution is always sooner or later restricted. Man's individual development, on the other hand, is potentially open. It continues throughout his life, and it can take place in all sorts of directions; while in animals there is only one normal pattern to be realized. This same sort of thing holds for man as a type - his pooled experience can be indefinitely added to, and it can be organized in an indefinite number of different ways. Animal types have limited possibilities, and sooner or later exhaust them: man has an unlimited field of possibilities, and he can never realize all of them. He has developed a new method of evolution: the transmission of organized experience by way of tradition, which supplements and largely overrides the automatic process of natural selection as the agency of change in the human phase (Huxley, 1960, pp. 28-29).

Clearly, in Huxley's view, behavior is infinitely variable once man shifts (learns) to compress meanings into terms which permit the pooling of experiences and concepts in immediate and

past time. This experiential pool, once crystallized into language may be used to classify events and relationships into plans to achieve future goals and if organized into a research structure, to predict new events in future time.

Edward Zigler views the developmental position as the province of psychology, one which is largely concerned with the effects of complex processes over extended periods of time, as contrasted with studies of behavior involving narrowly focused responses to very limited ranges of stimuli. Further, the developmentalist also focuses on locating focal points at which change occurs. Both positions are advanced in Zigler's following statement:

> ...The developmentalist is interested in change, not as a function of time, but rather as a group of organismic processes which take place over time. The developmentally-oriented psychologist has always been struck by the phenomena of growth and change and the orderliness, sequentiality, and apparent lawfulness of the transition taking place from the birth or conception of the organism to the attainment of maturity. The developmentalist's theoretical task has been one of constructing principle, or constructs making such change comprehensible. Such principles clearly have little to do with time and much to do with those processes, involving the person and his environment, which give rise to changes in behavior.

Stated in this way, developmental psychology becomes an extremely arbitrary subdivision of psychology. For if the concept of process is divorced from any particular developmental psychology with the psychology of learning, the orthodox learning theorist would handle observed changes in the effectiveness of his variables at different ages by introducing into his equations or predictions different values for the parameters of interest. The developmentalist is interested in a super-ordinate explanation of all such substitutions of values. While the learning theorist may change the values of his parameters from age to age, the developmentalist is concerned with

> discovering the transition rules for these changes, making the change itself, rather than the content of change, the central issue. (Zigler, 1963; pp. 344-45).

Zigler asserts that there is an important place for experimental research in developmental psychology. Further, the developmental research situation should provide a test condition which is generalizable to a much broader theater of action than the research setting. The developmentalist must be ready to accept error in his prediction due to the limited theoretical base; however, the price is not too high because, without research, there can be no significant movement forward:

> ...Only to the extent that we introduce some external criterion of validity can we choose or synthesize what is useful in those conceptual principles or constructs induced from naturalistic observation. To the author such a criterion is provided by the experimental method. As indicated earlier, many developmentalists have not fully comprehended the role of experiment in the validation process. In order to illuminate this relationship, a clear distinction must be drawn between two types of experiments. One type of experiment unquestionably represents an effort to mimic nature. That is, nature is brought into the laboratory, and a number of controls is exerted to discover the relationship between particular variables. This type of experiment falls on the same continuum with natural observation, its superiority lying in its efficiency. Thus, armed with a thermometer and the knowledge of how far above sea level various locations were, we could through naturalistic observations discover the temperature at which water boils and how air pressure affects this boiling point. But how much easier can we discover these relationships in the controlled situations provided by the experiment. However, many developmentalists find this type of experiment inapplicable to developmental psychology, and their view is probably partially correct. Much of the nature in which we are interested either cannot or should not be mimicked in the laboratory...
>
> A second type of experiment is more related to the problem of validating theoretical systems. This type of

experiment does not mimic, but rather creates, nature. Here the phenomena of nature are not brought into the laboratory, but instead phenomena are created which have little or no chance of being found outside of the laboratory. At this point the experimenter can be conceptualized as dealing with two distinct worlds, the world at large and the 'world' which he has created. Explanatory systems which are advanced, be they in physics or developmental psychology, are established to explain the real world...

Experiments do not test theories in their entirety, because of that portion of theories which is given, assumed, and untestable. However, the elemental principles or processes are tested, and the outcome of such tests determines the validity of the system. Thus, experiments of the second type are invariably of the theory-testing variety and involve the 'if such -- then such' paradigm. What the experimenter is saying is that if such and such holds in the real world because of the principles expounded in the particular theory under investigation, then such and such should hold in the world which the experimenter has created.

Developmental psychology does appear to contain unique interests and concerns which make it a delimited domain demanding approaches, methodologies, and theories having particular characteristics. What is required for such delimitation is not the definition that developmental psychology is concerned with change as a function of process, but rather that it is concerned with the changes in the form or organization of responses over time as contrasted with the change in the strength or accuracy of the response. What happens to a response after a prescribed number of trials is 'learning.' What happens over five years is 'development'. Thus, the developmentalist focuses on structural changes in a response, changes which cannot be defined simply in terms of changes which occur with single trials or stimulus presentations. (Ibid, p. 351-53).

Zigler indicates that there are substantive differences between the developmental position and that of Gesell, Piaget and Freud:

> ...Thus, the actual difference between Gesell and Piaget is not as great as one might initially imagine. The predictions derived from either system are limited almost entirely to sequential behaviors. Neither system has explicit concepts relating particular environmental factors to the nature of the sequence or to the content observed. This is true for Gesell because he is a maturationist, and, his notion of reciprocal interweaving to the contrary notwithstanding, such issues are viewed by him as pseudo-issues. It is true for Piaget because he is more interested in the general epistemological implication of the sequences than he is in the psychology of human behavior. However, we do not mean to imply that Piaget has not given us an extremely provocative system. Its prime value appears to rest not on its merit as a finished theory but rather on its susceptibility to translation, either in whole or in part, into more formally adequate theories or propositions...
>
> ...The tension-reduction, hedonistic approach to man, whether it stems from the Freudian or classic behavioral systems, has always been unacceptable to the developmentalist, for such a view simply does not reflect what developmentalists have grossly observed in the child's development. (Ibid, pp. 362-63)

Learning theorists are viewed by Zigler as too limited in their view of the human condition, and too overly concerned with upholding their own school of thought among the many micro-psychologies falling under the learning theory umbrella. However, Zigler is sympathetic towards efforts to test and explore such theories, but cool towards efforts to use developmental psychology as a means of dramatizing an entrenched theoretical position:

> ...Another factor that has made developmentalists wary of investigators with a learning theory approach

has been the reluctance of many of these investigators to become truly involved with and receptive to the total behavioral picture presented by the developing child. Such investigators appear much more committed to a particular learning theory than they are to the content area of developmental psychology. Their efforts have appeared to be directed more towards the demonstration of the applicability of a learning theory principle than to the unraveling of the central problems of growth and development. Such efforts are best exemplified in the numerous demonstrations that the Law of Effect does indeed hold for children and in that plethora of studies that attempt nothing more than the mechanical application to children of research designs originally employed with animal populations. Such investigations do little to refine the learning theories from which they were derived, nor are they of much assistance to the developmentalist attempting to illumine the mysteries of human development.

> This criticism, though a justifiable one, appears to have been overextended by many developmentalists. For many years a group of developmental psychologists, though beginning with classical learning theory, have been genuinely committed to the investigation of children's behavior and have been primarily concerned with the development of a learning theory capable of encompassing this behavior, rather than with the demonstration that the original theoretical efforts were valid. In almost every instance, the efforts of such investigators have resulted in the enrichment of the original theory employed, as well as adding to our understanding of children's behavior. Though the following listing is far from inclusive, such effort can be seen in the earlier work of Child, Whiting, the Nowlises, and the Searses, and in the more recent works of Berlyne, Gewirtz, Stevenson, Kessen, and the Kendlers. (Ibid; pp. 365-66).

The future of developmental psychology looks hopeful to Zigler. He sees the field as needing a more fully articulated

theory; thus, he takes a positive view of the influx of learning-theory based psychologists since they might possibly provide some impetus toward theoretical development through cross-fertilization:

> ...Developmental psychology is not only ready but badly in need of theories of the former sort, if for no other reason than to move us beyond our present state of knowledge. The construction of such theories is insured to the extent that we have investigators within developmental psychology who are imbued with a heritage which emphasizes the importance and value of theory construction and who are sophisticated as to the rigorous requirements of such an undertaking. The developmental psychologists with a learning-theory orientation appear to represent just such a heritage...(Ibid, p. 366.)

Baldwin (1967) makes the additional point that a psychological theory must be testable in the sense that it must result in predictions which can be established to be true or false in a way which communicates to others:

> The properties of a good language and a good theory are quite different. A theory should be testable, that is, falsifiable. A theory explains some behavior, but it declares that other behavior will not occur. A theory that can account for any conceivable behavior is untestable. A good language, on the other hand, should be able to express any content, whether it is true or not. It should be able to describe both possible and impossible situations. For example, nobody necessarily believes ghosts exist because he uses the word 'ghost.' The language needs, however, to contain the word as long as people have comments to make about ghosts, even if the comments only express skepticism about their existence. (p. 587).

Recent investigations in the developmental area involve the testing of key learning theory concepts related to the effects of contingency on behavior. Work by Hava and Jacob

Gewirtz illustrates this type of microscopic behavioral analysis. The central theme of the method is to attempt to trace and detail successive behavioral elements which occur between infant and parent. For example, if the infant initiates a given class of response, what parental consequence occurs and vice versa. This technique makes it possible to predict a given element of parental behavior, knowing a bit of infant behavior. The following passage illustrates the Gerwitz frame of reference:

> ...A number of reasonable contingency patterns emerge from an examination of behavior categories having substantial incidences of occurrence. These are characterized by cp values like those which, in a variety of analyses, could serve as individual difference measures (i.e., dependent variables). Some examples of patterns of adult responses to child behavior follow: the cps that a child's vocalization will be followed by adult talking in four Ss (one from each of our four environments) range from .52 to .81; the cps that a child's vocalization will be followed by an adult smile range from .21 to .42; the cps that a child's smile will be followed by an adult smile range from .46 to .88; and the cps that his smile will be followed by adult talking range from .25 to .51. Some examples of patterns of infant response to adult behavior for the same four Ss are the following: the cps that an infant's smile will follow an adult's approach range from .24 to .44; the cps that an infant's smile will follow an adult smile range from .50 to .79; and that an infant's smile will follow an adult's talking range from .30 to .57; and, lastly, the cps that an infant's vowel vocalization will follow an adult's talking range from .09 to .15.

In connection with adult-child contingency clusters, our preliminary impressions is, first, that aside from visual orientation responses, the child's predominant response to various adult

> initiations (e.g., approaches, smiles, talks, hugs) is smiling, regardless of the 'modality' of the adult's evoking initiation. In contrast, the adult's predominant responses to the child's initiations appear more to be of the same 'modality' as the initiator's, at least with respect to the child's smiles and vocalizations. Further analyses will determine whether such contingency clusters are a function of the stimulation in the environment, of developmental level, or perhaps whether they reflect only residual variation that is not to be explained in terms of the independent variables of this study. (Gewirtz and Gewirtz, 1969; pp. 246-47; italics in the original).

The Skinnerian behavioral position makes no assumptions as to genetic limitations. Learning is viewed as a process of immense intricacy and complexity which takes place dynamically under conditions of flux involving environmental stimulus, time, space and contingencies related to organismic drives and goals. Learning is viewed as stemming from the consequences of response. The position is an optimistic one, since it holds that once the process is more fully understood, learning efficiency will increase. Further, just as buildings cannot be properly assembled by tossing rocks, concrete and glass in a random fashion into a pile, so humans cannot learn properly unless there is a systematic and detailed engineering of all aspects of a learning problem.

Sidney Bijou has recently argued that behavioral principles, based on Skinner's and Keller's positions, would dramatically improve the rate at which children learn if they were applied within the school setting. The fact that this position is held by a small minority of psychologists, Bijou contends, is an obstacle to the rapid improvement of our educational system. He presents these concepts quite optimistically; behavioral analyses and theory are viewed as being ready to make major contributions now:

> ...Still another group of psychologists, which at present is only a small minority, responding to the question of what psychology can contribute to education now would say: 'We can offer a set of concepts and principles derived exclusively from experimental research; we can offer a methodology for applying these concepts and principles directly to teaching practices; we can offer a research design which deals with changes in the individual child (rather than inferring them from group averages); and we can offer a philosophy of science which insists on observable accounts of the relationships between individual behavior and its determining conditions.' (Bijou, 1970; p. 66).

Bijou lists five basic assumptions underlying the use of behavioral analysis to indicate the theoretical frame of reference for this minority. These assumptions appear completely general across psychology, except for Assumption #5, which seems to set up sub-assumptions and restrictions which might or might not have virtue in the classroom context. Bijou's assumptions are:

> ...1. The subject matter of psychology is the interaction between the behavior of an integral organism and environmental events. These interactions are analyzed in observable, measurable, and reproducible terms and therefore are amenable to scientific investigation.
>
> 2. The interactions between the behavior of an individual and environmental events are lawful. Given an individual with his unique biological endowment, changes in his psychological behavior are a function of his interactional history and the current situation in which he is behaving.
>
> 3. As in all of the sciences, the subject matter of psychology exists in continuities. Continuities are assumed to exist in the stages

of development, in the rates of development (normal, retarded, and accelerated), in the relationships between normal and pathological development, in the problems of procedures of basic and applied research, and in the analysis of psychological phenomena from raw data to theoretical formulation.

4. Complex interactions evolve from simple interactions and begin with the infant's initial relationships with people and objects. This does not mean that complex behaviors are assumed to be sums of simple behaviors. How a specific form of complex behavior, such as mathematical problem solving, is established is a problem for experimental study. The final analysis of any class of complex behavior would probably involve many concepts and principles such as minute stimulus control, subtle variations in setting conditions, and intricate schedules of reinforcement.

5. A psychological theory and its technology are open and flexible systems. That is, a new concept, a new principle, or a new technique may at any time be added to the existing list, provided that it can display the proper credentials: it must be tied unequivocally to observable events; it must be functional; and it must not overlap with the concepts, principles, or techniques already catalogued. (Ibid; pp. 66-67, italics in the original).

Assumption #5 appears to assert the sub-assumption that what is learned should be atomistic and mutually exclusive.

Bijou also makes a statement on teaching-oriented applied research which appears to be quite compatible with Zigler's view that competing learning environments should be compared with each other experimentally:

> ...The strategy of teaching-oriented applied research does not consist of designing a study to determine

> whether Method A is better than Method B for the teaching of subject-matter X. It is, instead, a search for ways to engineer an educational environment so that each child can learn specified tasks, and then, after that goal is attained, to compare achievement in that engineered situation with achievement in some other school situation. (Ibid, p. 67).

Bijou's view of the behavioral analysis schema is neatly summarized:

> ...Let us turn to the scheduling of stimulus materials. The fact that a school task can be learned with a minimum of frustration and on the basis of positive reinforcement via a program of differential reinforcement of successive approximations to the ultimate form of a response (skill), or the desired response in the proper situation (knowledge), has led to an over-emphasis on the role of teaching machines, and to a misconception about the school subjects that can be properly programmed. Teaching machines, from the most primitive to the most elaborate, are of value in teaching only insofar as they assist the teacher in arranging the contingencies that expedite learning, i.e., aid the teacher in presenting the material properly, in providing for explicit responses, and in arranging for optimum timing of effective contingencies of reinforcement. The programming of any academic subject for a child is straightforward: (1) state in objective terms the desired terminal or goal behavior, (2) assess the child's behavioral repertory relevant to the task, (3) arrange in sequence stimulus material or behavioral criteria for reinforcement, (4) start the child on that unit in the sequence to which he can respond correctly about 90% of the time, (5) manage the contingencies of reinforcement with the aid of teaching machines and other devices to strengthen successive approximations to the terminal behavior and to build conditioned reinforcers that are intrinsic to the task, and (6) keep records of the child's responses as a basis for modifying the materials and teaching procedures. (Ibid; p. 68).

To summarize Bijou's view of the idealized learning situation: presentation of content should be organized into discrete and digestible units, combined with intensive surveillance and precise responses by the teacher to insure proper reinforcement when, where, and under the conditions required.

The most powerful spokesman for the behavioral analysis position is, of course, B.F. Skinner whose work on operant conditioning has profoundly affected mid-century psychology. His later interest in improving the classroom as a learning environment, heralded by his teaching machines and programs, can be expected to generate major repercussions in psychoeducation in the years ahead. Skinner, in his meticulous way, describes contingencies of reinforcement in the following terms:

> ...The so-called 'contingencies of reinforcement' are an important feature of the independent variables studied in an experimental analysis. A few contingencies, such as conditioning, extinction, and delay of reinforcement are familiar.
>
> ...But many psychologists are unaware of the complexity of the contingencies now commonly studied. In addition to many standard schedules of reinforcement, reinforcement may be contingent on rate of responding, rate of change in rate, or specific patterns of rate changes detected by on-line computer analyses. Contingencies may involve several stimuli and responses interrelated in various ways. Considerable skill may be needed to design programs of instructional contingencies which will bring behavior under the control of complex terminal contingencies of this sort. The importance of programming is, indeed, often completely overlooked. For example, the statement that a given type of organism or an organism of a given age 'cannot solve a given kind of problem' is meaningless until the speaker has specified the programs which have been tried and considered the possibility that better ones may be designed.

Describing a set of contingencies in instructions to the subject is no substitute for exposing the subject to the contingencies, particularly when they need

to be programmed. Instructions have effects, of course, depending in part on the verbal history of the subject, but the behavior of a subject to whom an experimenter has explained how a piece of apparatus works will not necessarily resemble one who has come under the control of the terminal contingencies established by that apparatus.

Contingencies in reinforcement have been analyzed formally in theories of probability, decision-making, and games, but the theorist often has no way of knowing, aside from observation of his own behavior, what effects a given set of contingencies will have or what kind of program may be needed to make it effective. Certain assumptions -- for example, that an organism will behave rationally -- are sometimes used in lieu of observations to complete a statement of contingencies. Formal statements of contingencies, like instructions, have their effects and if detailed enough may supply rules which function as prior stimuli to control behavior resembling that which would be generated by prolonged exposure to the contingencies themselves. The two cases must, however, be clearly distinguished...

The increasing power of an experimental analysis has made it possible to examine the effects of complex contingencies to which an organism has traditionally been assumed to adjust only by exercising certain cognitive processes. It is sometimes obvious that such processes have been invented simply to account for the behavior in the absence of any better information as to how the contingencies could generate it. The experimenter has not been able to relate the behavior to the contingencies, and he is forced to conclude that the organism has somehow done so mentally. Supposed cognitive processes of this sort may be disregarded. Others, however, may be a sort of internalized version of precurrent behavior -- behavior maintained by its effects in maximizing the reinforcement of subsequent responses. Precurrent behavior is part of the subject matter of an experimental analysis. It is usually

> studied in overt form though it may eventually drop to the covert level. In either case it is defined as behavior which affects behavior rather than as mental activity. (Skinner, 1966; pp. 215-16).

Skinner then points out that his early animal work had been criticized as too narrow, but that time is on the side of those who hold fast to experimental analysis and carefully developed data:

> ...Unlike hypotheses, theories, and models, together with the statistical manipulations of data which support them, a smooth curve showing a change in probability of response as a function of a controlled variable is a fact in the bag, and there is no need to worry about it as one goes in search of others. The shortcomings and exceptions will be accounted for in time. The strategy is supported by the history of early criticisms of the Behavior of Organisms. It was said that the book was not about organisms but about the rat, and very small groups of rats at that. How could one be sure that other rats, let alone animals of other species, would behave in the same way? Only food and water were used as reinforcers, social reinforcers being conspicuously lacking. The stimuli--lights and buzzers--were crude and poorly controlled. Two levers should have been used so that the data would throw light on behavior at a choice point. And, after all, could we be sure that the rat was not pressing the lever simply because it had nothing else to do? These criticisms have all been answered without effort in the course of time simply as part of the normal development of the analysis.

Patience with respect to unexplored parts of a field is particularly important in a science of behavior because, as part of our own subject matter, we may be overwhelmed by the facts which remain to be explained. Subtle illusions, tricks of memory, the flashes which solve problems--these are fascinating phenomena, but it may be

that genuine explanations within the framework of a science of behavior, as distinguished from verbal principles or 'laws' or neurological hypotheses, are out of reach at the present time. To insist that a science of behavior give a rigorous account of such phenomena in its present state of knowledge is like asking the Gilbert of 1600 to explain a magnetic amplifier or the Faraday of 1840 to explain superconductivity. Early physcial scientists enjoyed a natural simplification of their subject matters. Many of the most subtle phenomena were to come into existance only through technical advances in the sciences themselves. Others, though occurring in nature, were not recognized as parts of their fields. The behavioral scientist enjoys no such natural protection. He is faced with the full range of the phenomena he studies. He must therefore more explicitly resolve to put first things first, moving on to more difficult things only when the power of his analysis permits.

> A final distinction. Those who engage in the experimental analysis of behavior are usually conspicuous for their enthusiasm. In a recent article Bixenstine (1964) attributes an unwarranted optimism in all behavioral science to the methodological position taken by experimental analysts. This is perhaps to overestimate their influence. In any case, he points to the wrong cause. He suggests that the optimism springs from release from the anxiety of theory construction. There is a more obvious explanation: the analysis works. (Ibid; pp. 217-18).

Skinner sees words as tools for imposing order and achieving goals. The word functions to trigger a reward-related response, much like an animal presses a bar to receive a pellet. It is a signal to produce something of value to the utterer and justifies the expenditure of energy by simplifying the attaining of a goal object:

> ...The verbal response 'Tea, please' may have two consequences: it may produce a cup of tea for the speaker

and may injure a friend by depriving him of the chance to ask for tea. These are separate consequences, having different effects on the probability that the response 'Tea, please' will be emitted. Under better conditions we could demonstrate this in a simple way. Insofar as the response is strong because it produces a cup of tea, we can alter its probability by making tea more or less reinforcing. Thus, by depriving the speaker of tea we can increase the probability that the response will occur, or by giving him a large quantity of tea before he speaks we can reduce the probability of the response. Insofar as the response has the effect of injuring a friend, we can alter its strength by altering the speaker's tendency to work injury. If we can persuade the friend to insult the speaker, for example, or in some other way increase the latter's tendency to take revenge, the probability of saying 'Tea, please' will rise. (In Hook, 1960; pp. 228-29).

Skinner presents a framework or set of working rules which suggest that a classroom can be organized as an elaborate programmed text or as a massive teaching machine. The teacher in this classroom operates as a high-speed program synthesizer, setting up contingencies, organizing sequences and reinforcing responses with precision, virtuosity, and minimal latency. One problem in this approach appears to be the location and training of larger number of such teachers. In addition, the educational perspective appears, at this point, to be limited to verbal and psychomotor skills, and does not extend to the child as a total socialized human being.

Theory must be considered a flexible scientific tool which provides a resource for the researcher, so that he may better achieve a research objective. The wave and corpuscular theories of light serve complementary functions for solving analogous but different problems. Theory, in any field, psychology included, need not become unitary; rather, it can serve as a tool for helping man to serve man. Frank, in a

beautifully lucid passage, presents a functional view of scientific theory which merits mention.

> ...In the same way that we enjoy the beauty and elegance of an airplane, we also enjoy the 'elegance' of the theory that makes the construction of the plane possible. In speaking about any actual machine, it is meaningless to ask whether the machine is 'true' in the sense of its being 'perfect.' We can ask only whether it is 'good' or sufficiently 'perfect' for a certain purpose. If we require speed as our purpose, the 'perfect' airplane will differ from one that is perfect for the purpose of endurance. The result will be different again if we choose safety, or fun, or convenience for reading and sleeping as our purpose. It is impossible to design an airplane that fulfills all these purposes in a maximal way. We have to make some compromises. But then, there is the question: Which is more important, speed or safety, or fun or endurance? These questions cannot be answered by any agreement taken from physical science. From the view point of 'science proper' the purpose is arbitrary, and science can teach us only how to construct a plane that achieves a specified speed with a specified degree of safety. There will be a debate, according to moral, political, and even religious lines, by which it will be determined how to produce the compromise. The policy-making authorities, from the logical viewpoint, 'free' to make their choice of which type of plane should be put into production. However, if we look at the situation from the viewpoint of a unified science that includes both physical and social science, we shall understand how the compromise between speed and safety, between fun and endurance is determined by the social conditions that produce the conditioned reflexes of the policy-makers. The conditioning may be achieved, for example, by letters written to congressmen. As a matter of fact, the building of a scientific theory is not essentially different from the building of an airplane. (Frank, 1956; pp. 13-14).

Frank's view of theory holds that a theory should:

1. Provide assistance in planning how to attain end point objectives.

2. Provide a tool to obtain different objectives depending upon context and requirements.

3. Be capable of improvement based on evidence of its own imperfections.

If we now consider the Maturational, Developmental and Skinnerian Behavioral positions in the light of the Frank position, we find:

(1) The Maturational position cannot assist in the formulation of a final product as the product preexists in the chromosomes. Theory is irrelevant as the ultimate behaviors inexorably mature.

(2) The Developmental Position has postulated a final product and specified many broad characersitics involved in the development of a well-rounded personality with sufficient skill levels to satisfy life requirements. There seems to be agreement among the developmentalists that, to attain these outcomes, there should be enriched and stimulating environment, empathic adults, opportunity for self-expression, variation in experience, understanding and support, etc. This fairly cohesive viewpoint has not been articulated into a rigorous theory but may be said to represent a "Developmental Approach". With reference to Frank's second point, there can be no shift in theory to meet varying objectives since the Developmental Approach has not been structured sufficiently to permit variation in approach to meet differing learner objectives.

(3) The Skinnerian Behavioral position does articulate a framework or set of rules which is substantially more rigorous than the Developmental Approach. However, it fails to indicate the total product other than to suggest that learning qua learning will take place more efficiently given application of the rules. With reference to the second requirement, adaptability, there is implicit in Skinner's work a periodic scheduling and some potential in terms of modification with a sufficiently adroit and knowledgeable teacher. Finally, Skinner has always modified his positions based on data and thus should increasingly improve the power of the behavioral paradigm in a classroom learning context.

The remainder of this paper is largely an exposition of the writer's personal positions vis-a-vis theory, systems building, and evaluation in education. Its objectives and scope are, by and large, consistent with those of developmental psychology. Though generally inconsistent with the maturational positions of Gesell, Piaget's work is viewed as a botanization of language development which offers little of value to the educator, despite the evident care of the execution. It will be clear to many readers that much is owed to Thorndike, Hull, Skinner, Keller, Symonds and Lange. There are clear and obvious differences as to some aspects of the human learning process. The writer's position, in essence, argues that learning is fundamentally a consequence of shifts in affect. Operations such as deprivation and shock are viewed as producing negative affect shifts, as is anxiety, apprehension, uncertainty, etc. The change in affective state which occurs following a response is the crucial condition for learning. If the shift is positive, learning takes place; the response tends to recur with increased frequency in the presence of the stimulus. In addition, the writer holds that affective relationships in humans fundamentally involve relationships with others. Man's psychological space is, for the most part, man. Thus, the development of affect shift contingencies, necessary for learning, can be obtained most efficiently in a social setting designed to provide high rates of response

and unlimited social rewards to the learners. In short, my position holds that schools, when viewed as learning societies in which all members are upwardly mobile, can be more efficient as learning systems, more satisfying to learners and staff, and provide greater variety, opportunity and freedom than is now the case.

STRUCTURING THE CONTINGENCIES FOR LEARNING[1]

Learning is fundamentally a matter of gratification (satisfaction, drive reduction, etc.) which occurs as a consequence of a response (positive affect shift). A vital function of any learning device or classroom method is to insure a high rate of positive affect shifts at appropriate times to increase learning efficiency. A corollary to this point is that the greater the affective investment by the learner in producing his response (everything else being equal), the greater his gratification when the response succeeds. A piece of educational equipment or a procedure designed so that the learner is emotionally involved in completing something meaningful--an equation, a map, or anatomical drawing, etc.--should be more efficient than one which merely requires him to press a button to indicate the most acceptable of several pre-selected options. The very energy invested for a meaningful response completion is an important consideration in the perceived gratification of success or the felt frustration of failure. Beyond this, the feedback following the learner response should be meaningful and functionally related to the problem or test item. The use of buzzers, lights, and other signals as feedback, though useful, fails to supply the learner with either the correct response or methods of overcoming error when his response is inadequate. Similarly, a test which provides the learner no information except scores marked wrong or right, fails to define either the proper response or the method of overcoming whatever errors exist.

Learning Contingencies:

Maslow has recently indicated that shifts in responses

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1. This summary overview of learning contingencies emphasizes affective consequences of response. The differences from the more generally accepted drive reduction and reinforcement positions reflect the viewpoint of this writer.

in the course of growth and self-realization are largely a matter of the affective consequences of response. He presents his views of the process in the following twelve points:

(1) The healthily spontaneous child, in his spontaneity, from within out, in response to his own inner Being, reaches out to the environment in wonder and interest, and expresses whatever skills he has,

(2) To the extent that he is not crippled by fear, to the extent that he feels safe enough to dare.

(3) In this process, that which gives him the delight-experience is fortuitously encountered, or is offered to him by helpers.

(4) He must be safe and self-accepting enough to be about to choose and prefer these delights, instead of being frightened by them.

(5) If he <u>can</u> choose these experiences which are validated by the experience of delight, then he can return to the experience, repeat it, savor it to the point of repletion, satiation or boredom.

(6) At this point, he shows the tendency to go on to more complex, richer experiences and accomplishments in the same sector (again, if he feels safe enough to dare.)

(7) Such experiences not only mean moving on, but have a feedback effect on the Self, in the feeling of certainty ('This I like; that I don't for <u>sure</u>'); of capability, mastery, self-trust, self-esteem.

(8) In this never ending series of choices of which life consists, the choice may generally be schematized as between safety (or, more broadly, defensiveness) and growth, and since only that child doesn't

need safety who already has it, we may expect the growth choice to be made by the safety-need gratified child. Only he can afford to be bold.

(9) In order to be able to choose in accord with his own nature and to develop it, the child must be permitted to retain the subjective experiences of delight and boredom, as the criteria of the correct choice for him. The alternative criterion is making the choice in terms of the wish of another person. The Self is lost when this happens. Also this constitutes restricting the choice to safety alone, since the child will give up trust in his own delight-criterion out of fear (of losing protection, love, etc.).

(10) If the choice is really a free one, and if the child is not crippled, then we may expect him ordinarily to choose progression forward.

(11) The evidence indicates that what delights the healthy child, what tastes good for him, is also, more frequently than not, 'best' for him in terms of far goals as perceivable by the spectator.

(12) In this process the environment (parents, therapists, teachers) is important in various ways, even though the ultimate choice must be made by the child:

a. it can gratify his basic needs for safety, belongingness, love and respect, so that he can feel unthreatened, autonomous, interested and spontaneous and thus dare to choose the unknown;

b. it can help by making the growth choice positively attractive and less dangerous, and by making the regressive choice less attractive and more costly. (Maslow, 1968; pp. 57-59; italics in the original.)

Some of the key elements needed for an effective learning system are schematically presented in Figure 1, The Learning Contingency Lattice. Cell A-2 asserts that whatever the learning system objectives (Cell A-1), the learner's previous experience must be used as the base. Learning is organismic and interdependent, and any new required learning product must base itself on what the learner perceives as personally important as learning goals (Cell A-3). The learner's involvement or readiness (Cell B-3) in the institutional objectives (A-1) is a primary consideration in designing a learning system. The system must accept his existing learning goals (A-3) and move to the learning system objectives (Cell A-1) and the stage achieved by the learner in his learning development (Cells A-2 and B-3). A sequential organization of learning materials (Cell A-3) is necessary to simplify the acquisition of skills and knowledge. Cell A-4 involves the development of an information network, either a lattice or a matrix so arranged that the complexity and difficulty of the items presented in the program and the success probability of the responses to them may be planned as part of the learning system specifications. These initial planning methods function as the backbone of the learning system and control (as does an architectural blueprint) the ultimate form of the system. The lattice permits the simultaneous exposure of all aspects of the system, permits control over the development of the materials to be presented, provides the basis for planning the learning sequence and response difficulty and is the basic tool for later evaluation of the system. Above all, it provides a method for controlling the rate of learner error (Cell C-4) which is the vital component in determining the learner's affective reaction to the system.

When errors occur with great frequency, the learner's resulting frustration may shift him outside the immediate learning context and produce various impulsive avoidance responses, such as noise-making, clowning, throwing and a host of anti-social behaviors. Conversely, when the learning system uses presentations constructed to minimize the possibility of error, the program is often perceived as monotonous or fatiguing; thus, affective investment of the learner is minimal, and the affective reaction (gratification or frustration) is sharply reduced (F-7).

THE LEARNING CONTINGENCY LATTICE

FIGURE I

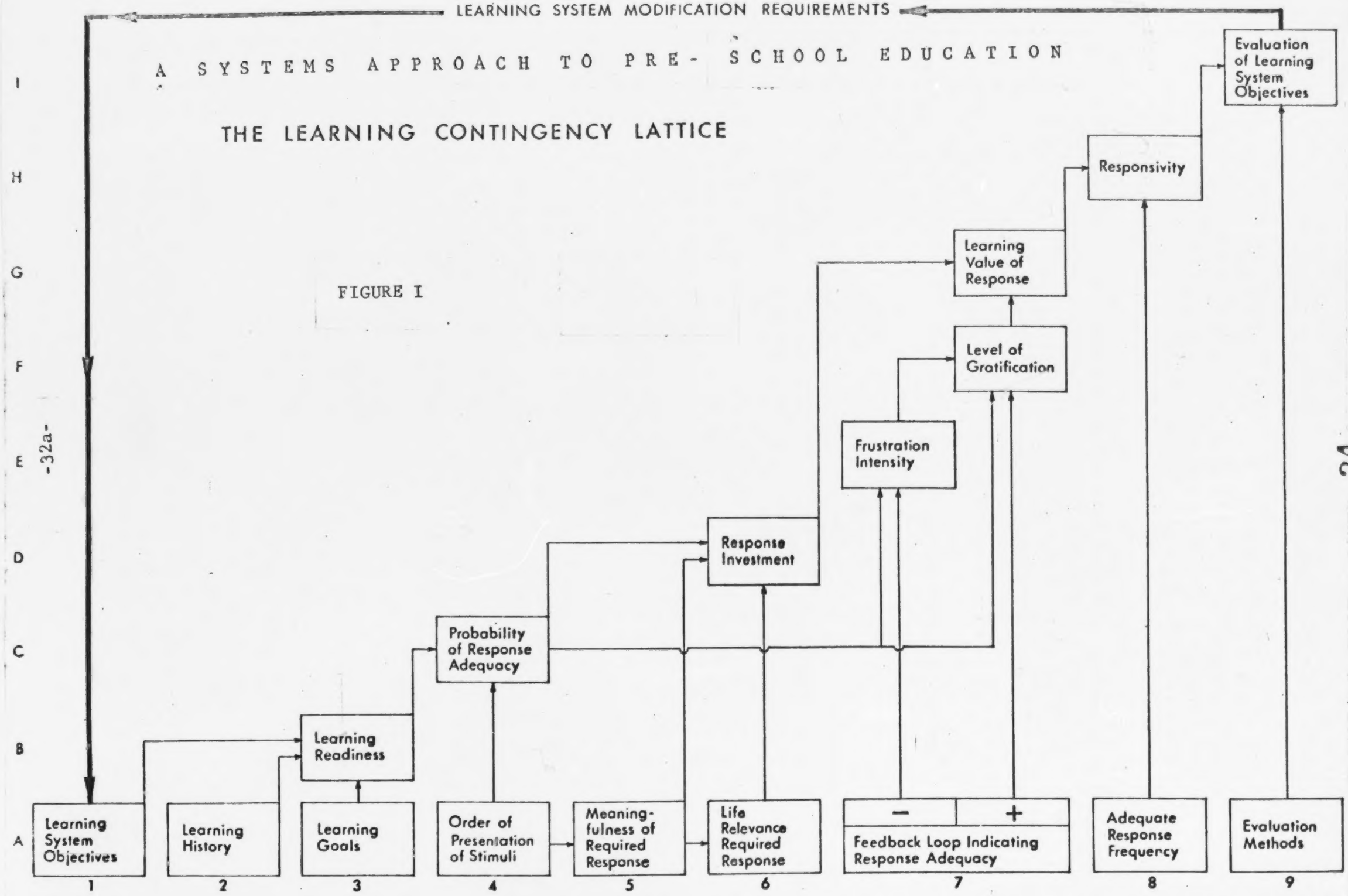


Fig. 1 This lattice indicates that an educational system must carefully control the probability of response error and at the same time must insure meaningfulness of response in order to obtain responses which have relatively high learning value for the learner.

Response requirements should be meaningful (A-5) and perceived by the learner as relevant to his own goals (A-3 and A-6). These aspects (A-3, A-5 and A-6) of the system requirements determine the degree to which the learner invests himself in the consequences of a response (Cell D-6). Thus, Cell D-6 is the fulcrum on which learning hinges; it is the index of affective involvement. It determines the magnitude of the learner's positive or negative affect shift following a response perceived as successful or unsuccessful. Response investment may be termed "motivation to learn." Learning systems are most effective when they produce "motivation" through controlling the conditions underlying the affective investment of the learners. Obviously, a high level of response investment produces greater frustration (Cell E-7) than a lower emotional commitment whenever an endeavor results in error. When, however, the learner makes an adequate response as determined by the feedback loop (Cell A-7), the learning value of a response (Cell G-7) is directly related to the level of gratification (Cell F-7) which is, in turn, determined by the level of response investment (Cell D-6).

The educational technologist who organizes learning systems is primarily concerned with maintaining the learning value of adequate responses by insuring that the learner perceives successive correct responses as evidence of achievement, rather than evidence that the work is too simple and a waste of time. The perception of achievement arises not only from the learning materials, which may or may not be viewed as important to the learner, but even more from the learner's personal values, interests and needs and the degree to which these are involved in the total learning context. An effective educational system is one where, regardless of prior learning history (Cell A-2) and initial learning goals (Cell A-3), the learner develops the skills required and is motivated to attain learning system objectives (Cell A-1).

A high response frequency alone has been shown repeatedly to be insufficient to improve learning performance when the learner does not know the results of his efforts. On the other hand, when the learner makes greater numbers of responses within a well-sequenced learning situation which delivers rapid feedback, response frequency (Cell A-8) makes a substantial contribution to the amount and depth of the learning outcomes. Thus,

high response rates are trivial or even counter-productive in the absence of other key factors in learning; however, when factors such as feedback, spacing, etc., are present, a high response rate is highly productive and indicates an efficient learning system (Cell H-8).

Once a learning system has been designed and put into operation, it should be monitored both in terms of its total function and its key components. The primary evaluation of the system involves the degree to which it is achieving its own learning objectives as specified in Cell A-1. This evaluation may be performed in absolute terms. Suppose, for example, that the system objectives were limited to (1) a 9th grade reading level and (2) command of pre-algebraic arithmetic. Several appropriate measuring devices could be used on samples of learners, employing equivalent but differing sets of items. The scores could be set up diagnostically across each area to expose areas of system weakness. The rate of acceleration of the means would be an important index of system effectiveness, as would measures of dispersion, forms of the distribution, etc.

In addition, measures could be taken of such key sub-components as error rate (Cell C-4), learner reactions to meaningfulness (Cell A-5) and relevancy (Cell A-6) and the mean and variance of the response rate (Cell A-8). Once all the information had been collected, data would be analyzed to expose areas of weakness of the learning system for purposes of revision. Where necessary, this data could lead to substantive system modification. In turn, this might result in changes in system objectives and components. (See the system modification loop flowing from system evaluation (Cell I-9) back to system objectives (Cell A-1)). In addition to evaluations to upgrade a learning system, evaluations should also be made to compare the relative effectiveness of different learning systems where each seeks to attain similar learning objectives.

Evaluation instruments must measure the learner product following graduation from a learning system. A pre-school system should be measured in part by ability to perform effectively in elementary school. Post-system performance and adaptation could then be combined with the within-system information to

provide criteria for system modification as well as new system objectives. New learning standards would evolve for the pre-school system as changes occurred in the elementary system requirements. In a complex, evolving society such as ours, educational technology must also evolve to concurrently conform with and support changes in the technology of the total society.

Further, education cannot bypass its own moral obligations. Amorality in education can be as destructive as condoning immorality. Childs describes the moral responsibility of the educator extremely well:

> ...The moral nature of education stems from the fact that schools are organized and maintained by adults, not by the children who attend them. Adults engage in deliberate education because they are concerned to direct the processes by which their children mature and learn to become participating members of their society. A manifestation of preference for certain patterns of living as opposed to others is therefore inherent in every program of deliberate education. Schools always exhibit in their purposes and programs of study that which the adults of a society have come to prize in their experience and deeply desire to nurture in their own children. Hence the curriculum of a school is an index to the values of the particular human group that founds the school. It is because some conception of what is humanly significant and desirable is implicit in all nurture of the young that we may say without exaggeration that each program of deliberate education is, by nature, a moral undertaking. (Childs, 1960; p. 96).

THE FAMILY AS A LEARNING SYSTEM

The family is assumed to be a learning system which sets up contingencies for establishing and strengthening the two spectra of responses which we term personality, that is, those covering the spectra of habituated performance and verbal behaviors. Initial infant skills, formed through relative rates of success in achieving goals, become deeply imbedded and form the basis for an interlocking set of related skills. The child who is successful in attaining goals through language as an instrumental tool develops an elaborate language network to increase the range, speed and specificity of the goals he can acquire. Where goal success is based on psychomotor activities, these too proliferate. Finally, where skills are developed which annoy, frighten and obstruct adults as a device for attaining goals, obstructive and annoyance behaviors multiply.

In our society the home, church, and community have been inundated with insoluble problems of mobility, technology, pollution, crime and violence at home and war abroad. The educational system appears to be the only institutional structure which has the basic stability, time, personnel and equipment to prepare a large proportion of American youngsters for adulthood. Historically, of course, the educational system has been responsible for insuring adult readiness. However, in our epoch, educational problems are an even more crucial social imperative which directly affect our viability.

In addition, learning problems are increasingly more demanding for students. At the same time, the resources of the home, community, and church provide appreciably less buoyancy and support to assist the educators in their more difficult task.

If the school entry point is considered as kindergarten (or as first grade, as in many locales), we are considering a human being with about 44,000 hours of life of which approximately 30,000 have been spent awake. During this period, the child has made literally millions of responses to achieve

an enormous spectrum of goals. Some of his goal directed responses are personal and direct; they involve pulling, grabbing, reaching, grasping, holding, crawling, climbing, walking, and other such behaviors where the goal is perceived and then attained by self-effort. However, the great bulk of the goal seeking responses, particularly in the early life stages, requires adult intervention. This indirect method of goal attainment is dependent upon the use of signals which indicate the existence of need for the goal object. For the very young child, this entails a type of psycho-motor signal, epitomized by pointing, gesturing, change in facial expression (e.g., smiling or frowning), reorientation of body position, holding up both arms to be lifted, etc. Here the adult goal supplier is required to make an interpretation of the signal value of the expression or posture and respond with the appropriate goal associated stimulus, if possible. In addition to attainment of goals through direct and indirect psycho-motor means, the child has a battery of sounds which are interpreted as signals requiring adult intervention. At an early stage, these include such sounds as crying, laughing, screaming, cooing, babbling, gurgling, and speech mimicry. In addition to these voice-box sound emissions, there are body sounds which serve as signals indicating interventional requirements such as cleaning and diaper changes.

The central point is that, at the earliest life stage, there is a psycho-motor mode and also a sounding mode for goal attainment. The pattern of adult response to these modes, varies, of course, from family to family. The infant behavior occurs in a cultural matrix involving physical space, a variety of objects, and the interaction of a family social system which, regardless of its previous behavioral equilibrium, must adapt to some extent in accommodation to the new family member. For purposes of this analysis, it is assumed that families and individual members differ along four major dimensions: (1) Environmental Richness; (2) Symbolic Exchange; (3) Parental Response Thresholds; and, (4) Parental Responsitivity. Each of these four dimensions is presented along a five point scale in Table 1 (The Family as a Learning System). We may, using this scale, evaluate the environmental matrix of the infant by patterns such as (A-4, B-4, C-5 and D-4) (A-1, B-2, C-1, D-2), etc. The scales have been designed so that the higher the number, the greater the value for accelerating the development of

VALUES	ENVIRONMENTAL RICHNESS (Levels of Stimulation)	SYMBOLIC EXCHANGE (Meaningfulness)	PARENTAL RESPONSE THRESHOLDS (Reactivity Modes)	PARENTAL RESPONSIVITY (Feedback Modes)
Level 1	HOME AS CAPSULE Family is isolated and does not interact with outsiders.	VERY LITTLE MEANING Verbalizations rare and responses are brief and often monosyllabic.	VERY LOW THRESHOLD Parents provide desired goal stimulus immediately rather than tolerate noise or tension-producing activity.	NO FEEDBACK Parent behavior unloving and self-determined. Overt behavior of child has no impact on parent attitude or behavior.
Level 2	NEIGHBORHOOD CAPSULE Family interacts only with itself and other families within narrow social and geographical area.	HIGH AMBIGUITY Verbalization is guarded. Meaning is opaque and listener must guess at meaning and emotional content. Speech interactions very rare.	MINIMAL TOLERANCE Parents usually provide desired goal stimulus rather than tolerate noise or tension-producing activity.	ACCEPTING-UNRESPONSIVE Parent behavior is loving but self-determined and child has little impact. Rigid parent behaviors are only slightly affected by child's responses.
Level 3	COMMUNITY LEVEL Family interacts with other families and individuals within the community area.	PARTIAL AMBIGUITY Verbalization is often guarded but has wide range. Interpretation is sometimes given spontaneously but usually in response to direct question.	MODERATE TOLERANCE Parents often provide desired goal stimulus but child often fails to achieve it because of noise or tension-producing activity.	DUTIFUL-FLEXIBLE Parent behavior maintains warmth and is responsible to child. Standards are reasonable and child is aware of own success or failure.

	Level 4	INTER-COMMUNITY LEVEL Family interacts with other families and individuals in other geographic locales.	FULL COMMUNICATION Speech is informative. Language has wide range of tone and content. Sustained responsive interactions in speech.	HIGH THRESHOLD Parents usually resist producing goal stimulus under duress of noise and tension-producing activity and tend to respond when child is socially adaptive and non-destructive.	ACCEPTING-FLEXIBLE Parents attentive and responsive. Respond selectively to needs quickly based on child's response. Flexibly adapt as child matures.
	Level 5	MOBILE INTER-SOCIAL Family has wide social interactions across groups and in varying locales and cultures.	INTERACTIVE COMMUNICATION Speech is informed and has high symbolic content. Great facility with language, both common and literary. Responsive to shadings of meanings insure comprehension.	FLEXIBLE THRESHOLD a. Parents resist response to tension-producing activity. b. Parents provide alternative, socially accepted modes for obtaining goal. c. Parents systematically provide goals for verbal and adaptive behaviors. Verbal interactions are sustained.	RESPONSIVE DEVELOPMENTAL Parents are loving and supportive and highly responsive to child and apply shifting standards to increase skill levels. Planning done to insure growth in abilities under conditions of adequate success probability.

language and social skills. A comparison between two Family Learning Systems is made below.

COMPARISON BETWEEN TWO FAMILY LEARNING SYSTEMS
Table 2

Scale Value	Family A	Family B	Scale Value
A-4	Inter-Community Level Family interacts with other families and individuals in other geographic locales.	Home as Capsule Family is isolated and does not interact with outsiders.	A-1
B-4	Full Communication Speech is informative. Language has wide range of tone and content. Sustained responsive interactions in speech.	High Ambiguity Verbalization is guarded. Meaning is opaque and listener must guess at meaning and emotional content. Speech interactions very rare.	B-2
C-5	Flexible Threshold a. Parents resist response to tension producing activity. b. Parents provide alternative, socially accepted modes for obtaining goal. c. Parents systematically provide goals for verbal and adaptive behaviors. Verbal interactions are sustained.	Very Low Threshold Parents provide desired, goal stimulus immediately rather than tolerate noise or tension-producing activity.	C-1
D-4	Accepting-Flexible Parents attentive and responsive. Respond selectively to needs quickly based on child's response. Flexibly adapt as child matures.	Accepting-Unresponsive Paren behavior is loving but self-determined and child has little impact. Rigid behaviors are only slightly affected by child's responses.	D-2

The child from Family A is in an enriched physical environment, stimulated by variations in objects, colors, sounds, etc., contacts a wide range of other types of people, and hears many different vocal patterns (A-4).

The child from Family B, on the other hand, is largely limited to the same four walls with little variation in form, color and sound patterns. The family members largely represent repetitive stimuli in terms of physical appearance, voice sounds and manner, etc. Child A is in an ever varying environment which can provide him both stimulation and gratification. The many objects he encounters have a variety of terms identifying them which, if learned, provide the basis for an expanding vocabulary. Child A is also more advantaged in terms of the specificity of the language used in the home. Further, Family A uses interactive speech whereas the speech patterns in Family B tend to involve only delivery statements and rarely include sustained exchanges involving information delivery, receipt, delivery, etc. (speech chains). Thus, the Family A child has an immensely greater opportunity to learn speech and to utilize language as a tool to obtain goal objects, social interactions, and to make known those wants which can only be satisfied by appropriate parental behaviors.

The D scale relates to the immediacy of the satisfaction obtained by the child as a consequence of a goal related response. In Family A, the parents are attentive to the child and provide goals quickly and selectively, taking into account the child's needs and state of development (Level D-4). In family B, on the other hand, the child is given little attention; his responses go unheeded, and his parents tend to his needs on the basis of parental convenience or some pre-determined schedule. Thus, the goal attainment level for any given sequence of response will tend to be considerably higher for the child in Family A than for the child in Family B who obtains little or no benefit in terms of goal attainment from goal-related responses he makes to parents.

Finally, in Family A, the parents are selective as to which kinds of responses produce regard. Crying, pounding, screaming, shrieking, complaining, and sulking responses are given little attention unless there is some indication of pain or distress. They tend to respond to facial expressions, body movements, voice sounds, and actual speech, to wait for more meaningful types of behavior, and to be tolerant of high noise levels. However, in Family B, the child, unable to obtain goal objects by other means, may increase his noise level, aggressive behavior (or withdrawal behaviors) to the point where the parents must take notice. If parents have a low threshold, physical activity and mere noise may produce goal objects, social involvement, and gratifying events more efficiently than expression, gestures, speech signals or language.

Family A then, may be viewed as a social system in equilibrium in which the new member learns how to maximize goal attainment with minimal energy expenditure. To obtain his goals, the child in Family A learns to signal his parents in a variety of ways, and speech becomes a functional life tool. Child B, however, may become relatively nonverbal, aggressive and impulsive since these expressions may be the most functional means of goal attainment in his family.

Where speech is more functional as a goal generating tool, it evolves and is elaborated; however, the language oriented child may construct elaborate fantasies to produce a broader variety of goals than the parents can or will deliver. The central point is, of course, that both children have developed efficient response repertoires in terms of maximizing goal achievement per unit of energy expended.

In a more precise convention then, we may simple state that, all other things being equal, learning (L) always takes place in the direction of maximal yield (M) per unit of energy expended (E)

$$L = \frac{M}{E}$$

where yield is considered to be the perceived goal requirements

of the learner. As the child moves across his available response spectrum, he tends to emphasize and accentuate those responses which generally yield the greater return for the effort made. The parental patterns that exist in the initial infant learning environment generate the initial infant response pattern which, over time, is elaborated into a complex response network. However, the kinds of responses which tend to dominate are determined almost totally by the response tendencies of significant adults during the first years of life.

If we assume that the intra-familial learning contingencies sketched out in Table 1 operate as a learning system, then it may well be hypothesized that family interaction patterns develop four major categories of child goal attainment behavior:

(1) Static: low in motor and symbolic responses.

(2) Motoric: high activity, low in symbolic skills.

(3) Symbolic: high verbal skills, low motor skills.

(4) Indirect-Obstructive: Both motor and symbolic skills force others to act.

If we assume that these initial goal attainment behaviors have (in the jargon) great response strength and thus form a basic life theme, then later responses tend to be complex patterns and variations of this initial behavioral melody. The tree leans as the twig is bent; the child is father to the man.

It may be that for thousands of years, the most adaptive and successful human beings were high motoric--low verbal, and that such children would have been much favored over the verbalizing studious, sometimes challenging or contentious child. Certainly the motoric pattern would be highly adaptive in a hunting and farm culture. There are dozens of patterns in "The Family as a Learning System" Scale which would result in such a pattern. Almost any combination which would include

A-1, A-2 and A-3; B-1 and B-2; C-3, C-4, C-5; and D-2, D-3 and D-4.

However, for the child in our culture, this is an era of symbolic mastery, a meritocracy where early symbolic skills lead to classroom victories, quickly followed by the attainment of technical skills as an engineer, lawyer, medical doctor, educator, or businessman. Cultures which emphasize symbolic skills for the very young may produce high performance adults as an artifact of early symbolic stimulation, parental responsivity and feedback. The higher adult performance levels of the middle class, the professionals and the upwardly mobile who emerge out of the urban and rural ghettos, may reflect a similar (though less probable) accidental pattern of interaction in the home rather than some genetic template which predestined them for success.

In this analysis, the family as a learning system is the crucial generator of the behaviors possessed by the very young; genetic determinism is a metaphysics which utilizes the jargon and technique of research to propound predestination. Predestination theories ultimately lead to a kismet philosophy; it has been written (in the chromosomes) and, therefore, the psychologist can only observe. Genetic determinism presumes that systematic psychoeducational approaches will be eternally powerless. In the present analysis, the alternative option appears far more reasonable -- that is, it is assumed that systematic and organized efforts to improve the learning efficiency of our children will make substantial differences in learner performance capabilities. We cannot afford a metaphysics of genetics to explain educability, any more than we can pin our faith on the infallibility of the teaching machine, TV, or teacher creativity. We must face the necessity to (1) design pre-school systems to meet the specific life objectives of children today; (2) develop and test protype systems and evaluate how well they meet their objectives; and, (3) proliferate and continually evaluate, revise and upgrade the systems to improve the learning efficiency of the children.

A SYSTEMS PERSPECTIVE

Coordinated and planned efforts involving money, personnel, methods, equipment, materials, transportation, etc., to achieve a given objective are classifiable as systems. A bank, a school, or an aircraft factory may be a system in the sense that each involves an input and a complex method of processing that involves many factors to attain a definable output. Systems are purposeful; their processing methods and quality control techniques convert a relatively raw input into a specified output. Some systems, such as banks, offer few problems. The product (increased in dollars) is seeable, touchable, feelable, discrete, and above all, countable. The input of the system can be readily identified by agreed-upon accounting procedures and the efficiency ascertained by the difference between numbers of dollars of input and numbers of dollars of output. The difference in dollars, whether stated in earnings, percentage, stock dividends or profits, is an index of gain generated by the system. The efficiency or inefficiency of the system is easily judged by the relative rate of gain in output compared to other banks in similar circumstances.

The input in a pre-school, on the other hand, is a child whose capabilities are largely unknown and, the output, for the most part, is of no concern to educators. Further education involves non-observable capabilities which are uniquely combined in each individual in unknown ways. Measures of learner performance level may be in serious error because of factors such as: language, including misunderstanding of instructions, usage, expression, colloquialism and dialect differences; resistance of the examinee; bias of the examiner; poor administration; failure to standardize the test environments; distractions; anxieties evoked in the examinee which suppress known information or skills; preknowledge of test questions; errors in assessing the adequacy of the response, etc. Beyond this, the numerical sequence of test scores fails to satisfy the unit distance requirement for cardinality and, in addition, the test items blithely span dimensions. This results in scores where greater numbers do not necessarily mean greater knowledge

or skill along any clearly defined dimension. This in turn makes all later statistical manipulation of dubious value.

This analysis holds that, in spite of the difficulties of goal-product definition and measurement, and the complexity of our technology and social system, education is powerless to solve its problems without highly sophisticated systems. Humans, unlike objects, are idiosyncratic and dynamic, vary from moment to moment, evolve with different learning histories, perceive, excite, conceptualize, and differ in their objectives and values; thus, educational systems must be much more sophisticated than systems concerned with earnings, getting men to the moon, or processing food. Within this framework, learning systems for children should be concerned with developing the following output products:

(1) A strong sense of personal independence and adequacy combined with the personal initiative to establish goals and the stamina and flexibility to attain them.

(2)a. A strong language base that provides the terms necessary for description, denotation, and classification by category. Ability to use terms functionally as tools to organize and plan in order to attain personal goals.

b. Skills in communicating to others at a verbal level and the attention and comprehension necessary to obtain information from others.

c. A sufficient level of reading skill to permit pre-school children to increase their vocabulary independently, along with printing skills sufficient to record the words they know.

(3)a. Ability to work easily and readily with others to cooperatively perform a task which could not be performed alone.

b. Readiness to work with adults as required, with minimum dependency on adults for supervision and control.

c. Readiness to accept responsibility and assist others where required and to accept assistance in the interest of achieving a personal or shared objective. All aspects of learner performance should reflect an empathetic awareness of the importance of the other's needs.

(4) The curbing of impulsive and anti-social behaviors which prevent learning by the individual learner, or interfere with the efforts of others to perform. Thus, a learning system should be so designed to shift response patterns, where required, from anti-social or asocial behaviors to behaviors which provide basic satisfactions through learning itself, self-expression, and social-interactions.

The output measures for a pre-school learning system should correspond to the system objectives. The adequacy of the measures will be crucial for determining the effectiveness of the system and central to the problem of making comparisons of the relative effectiveness of different systems. The present measurement of performance in educational settings is, at best, inadequate. The development of learning systems will require new, imaginative and pertinent measuring methods. For pre-school systems, several kinds of output measures appear to be indicated. Performance should be sampled across the total range of life skills including:

(1)a. Language skills in which meaningfulness of language covers verbal comprehension skills, precision, denotation, and functional value of terms in English and in learner's family linked language.

b. Ability to classify and analyze higher order terms into lower order relationships; understanding of mapping relationships related to the body, home, classroom, etc.; understanding of the functions of objects and related terms. The depth, extent and precision of language terms should also be known.

c. Adequate reading skills (as assessed by diagnostic reading skill tests which provide valid indices of areas of uncertainty of sound and letter pattern relationships at varying levels of stimulus and response complexity).

(2) Social interaction skills with peers and adults in standardized performance task situations involving goal attainment.

(3) Goal attainment skills involving measures of stamina, flexibility, perseverance and ingenuity,

(4) Adequate degree of control over impulsive avoidance and aggressive behaviors under conditions involving combined efforts with others.

(5) Ability to utilize and act to attain goals at varying points in future time.

(6) Ability to maintain attention to tasks over extended time periods in the absence of immediate personal gratification or reward.

Pre-school learning systems, in particular, must be designed to overcome handicaps generated in the home and community, at every socio-economic level. They should provide the basic skills necessary to meet the standards of elementary school while preparing children to contribute, participate and adapt to the infinite variety of conditions in the home and community. Above all, our pre-school systems must be viewed as providing the keystone learning for adult Americans.

The freedom to make choices in a democracy implies that citizens are sufficiently skilled to make those choices which function for goal attainment. Education must move beyond teaching punctate elements to satisfy multiple choice test requirements, and provide the language, planning, emotional control and flexibility necessary to maintain control over one's personal destiny. This writer views a well articulated pattern of learning systems, beginning with pre-school, as offering the following capabilities through education:

(1) Developing a commitment to personal freedom that extends not only to the individual himself but to all members of a free society, functioning within a constitutional democracy.

(2) Developing problem-solving skills that require inter-relating, complex concepts, establishing sequences of activities, and the flexibility necessary to adapt to situational variations.

(3) Developing sufficient emotional control to continue to perform effectively under difficulty, whether as a member of a team or as an individual.

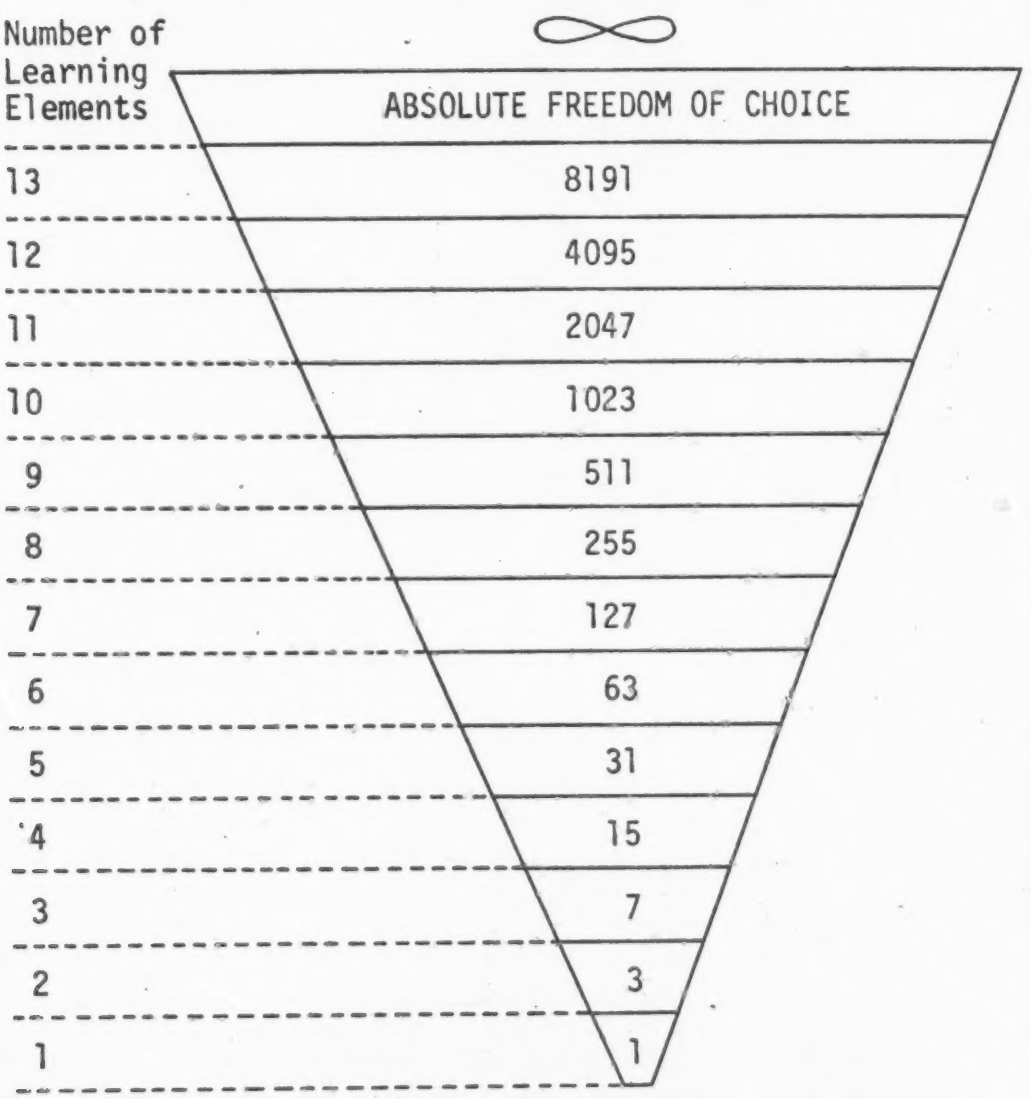
Learning systems, properly designed, can become the basic agency for developing the complex skills required to feel technically and socially adequate to function as a free individual in our technical society. (See Figure 2, The Wedge of Choice and Freedom In a Hypothetical Thirteen Learning Element Situation).

A Preliminary Learning System Overview:

There are eight crucial considerations in designing a learning system: (See Figure 3 - Lattice for Learning System Prototype).

(1) Theory (Cell A-1): The theory should be fully articulated with interlocking assumptions which provide direction, focus, and a guiding rationale for those responsible for conceptualizing a system design. Above all, it should provide a basis for selection of methods of assumed greater effectiveness. The theory must be directional (rather than circular) so that it can be assessed as adequate or inadequate. depending on its predictive power. Further, it should be capable of modification and improvement as a consequence of data obtained

The Wedge of Choice and Freedom In A Hypothetical Thirteen Learning Element Situation



As the learner increases the number of successful choices, he becomes increasingly free to obtain personal goals. The number within each successive segment of the wedge (choice fields) are illustrative only. They indicate that at each successive choice field, the number of choices increases by a factor of $2x + 1$ where x is the number of choices which could be made in the just previous choice field.

If the learning elements are considered to be letters of the alphabet, this wedge indicates that when one letter is known, the learner can read one word, two letters permit him to read three words, three letters permit him to read seven words and so on. When all thirteen learning elements have been mastered, then the learner can make all possible choices to attain any goal involving these thirteen elements. At this point he has total freedom within this (thirteen learning element) field of choice.

FIGURE II

from realistic tests of the performance of output learners.

(2) The Philosophic Aspect of a Learning System (Cell A-2):

A theory specifies certain formal assumptions about the learning process; however, a philosophy provides the direction, boundaries and limits for the theory's application. The theory functions within a value system which specifies how it will be used. A system which functions effectively to control behavior could be used to enslave or to free. The philosophy underlying the use of the system determines the way it is put into effect.

(3) The Assumptive Framework (Cell B-2): The conceptual convergence of the theory and the educational philosophy form the basis for the total set of assumptions used to develop a given educational system. The assumptions underlying the theoretical system combine with the philosophic assumptions to form the assumptive set on which the learning system is based. These establish the degrees of conceptual freedom and the limits which will control the design of the new learning system.

(4) The System Objectives (Cell C-3): Once the system assumptions have been established, educational goals must be sharply and unambiguously delineated. An educational system, for example, can limit itself to learning of a particular body of content or it can seek to affect broader ranges of behavior such as aggression, withdrawal, and problem solving skills. System objectives are absolutely limited by assumptions in the theory, and philosophy, whether or not these have been formally exposed. They may be

Lattice for Learning System Prototype

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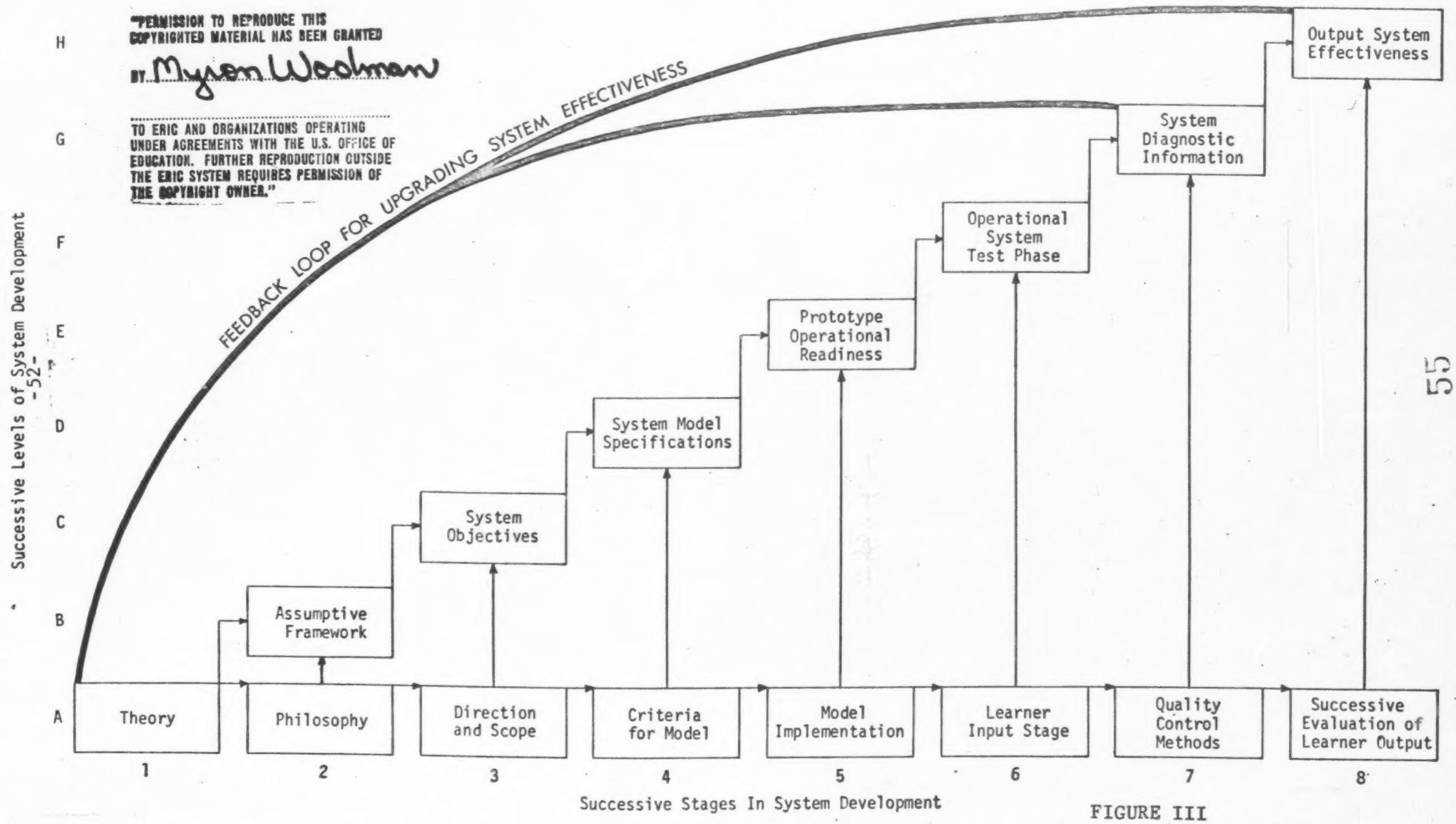

FIGURE III

A lattice indicating the key stages involved in developing a learning system.

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as broad as a commitment to the whole person, or as narrow as a change in the frequency of a learner who pulls the lever on a pin-ball machine.

(5) Establishing the Specifications for the Prototype System (Cell D-4): All planning and specifications for the system are essentially the establishment of a network of interlocking activities which utilize the assumptions to satisy system objectives. The design of the classroom, the learning materials, equipment, learner behavior, role of the teacher and other adults, administrative methods, discipline, the sequencing of inputs, the classroom decor, etc., must be specified in detail and interlock into a single organic system. The basic constraint during the planning phase is that each aspect of each plan must be based on criteria (Cell A-4) which are consistent with the assumptions, philosophy and ultimately the basic theory under test. The level of detail of the specifications should be sufficient to put a team to work to transform them into an operational learning system, much as a set of blueprints is used by an architect to specify construction requirements.

(6) Operational Readiness (Cell E-5): Once the prototype of an innovative system exists, a new range of activities is required for it to function as designated in a community or school context. These activities include such areas as: initial selection of children; community and parent relationships; teacher selection; relationships with the sponsoring organization and the local school system; and careful orientation of political leaders and personalities to avoid misunderstandings. Community understanding of the system and its objectives is fundamental to a meaningful

operational test. Once system specifications have been operationally transformed, the vital problem is to insure that staff are sufficiently well trained and are knowledgable about the system. The operational staff's responsibilities should be committed to testing the system as planned rather than the improvisation of casual alternatives. In addition, teacher training methods, in-service training, teacher critiques, etc., must be planned to insure that the learning system operates within its own theoretical and philosophical boundaries.

(7) System Diagnostic Measures (Cell G-7): The evaluation of system performance requires a comparison between what happens in the course of actual system operation and what was planned in the system specifications. Such evaluations cover learning rates and whether or not the equipment and material function as planned in terms of teacher and learner performance, parental reaction, etc. The diagnostic evaluations are designed to insure, to the extent possible, that each of the elements of the operation system function as initially planned. The diagnostic method should expose non-compliance or misinterpretation so that steps may be taken to correct the use of a particular component. On the other hand, where a component is being used properly but fails to function effectively, it should be modified, eliminated and/or replaced. This aspect of the evaluation should be indifferent to those parts of the system which are functioning effectively. It is a method of evaluation by exception.

(8) System Output Measures (Cell H-8): The purpose of a learning system is to insure specific kinds of life skills after some pre-specified time

> interval. System output measures should be designed to provide an accurate measure of the system's effectiveness in attaining its objectives, as related to the total learner population. Such measurement might cover language skill gains; change in social effectiveness in interactions with peers and adults; level of emotional control as related to aggressive, impulsive, withdrawal and anti-social behaviors; ability of the learner to achieve goals on his own initiative and willingness to sustain efforts to achieve goals; and the use of creative ingenuity in problem solving.

A very important measure of system effectiveness lies in determining whether changes are restricted to the learning setting or generalize to the home and community. The most vital measure in this analysis involves the learner's adaptability and performance after graduation from the pre-school system, that is, in first grade and later.

The preceding preliminary view of the components of a learning system will be presented in somewhat greater detail in the following sections. A pre-school learning system, now in its operational phase, will be used to illustrate system relationships. This system has recently completed its first operational year and its actual output capabilities are not yet known.[2]

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2. The Micro-Social Learning Center, a New Jersey State Department of Education Demonstration Project, which operates in cooperation with the Vineland Board of Education, Vineland, New Jersey.

TOWARDS A PSYCHO-SOCIAL THEORY OF CLASSROOM LEARNING

Classroom as a Life Simulator

In a complex, mobile society which is ethnically and linguistically heterogenous, the pre-school is the only institution which can provide the cohesion in language and behavior that is imperative if later school experiences are to have value. Pre-schools are the most important institutionalized learning systems because they provide the matrix skills which must transfer to elementary, secondary, college, vocational performance, and to the family and community.

A democratic, individualistic, technical society poses special problems for education because the adult product must possess: (1) a broadly based language delivery and comprehension capability; (2) social skills required to work in groups as a team leader, member and/or subordinate; (3) tolerance for stress and frustration to resist impulsive, avoidance, and aggressive behaviors in work, family and community contexts; and, (4) ability to plan, organize and maintain goal directed activities over extended time periods. The classroom complex, when viewed as a system for generating responses, must be so organized as to insure life survival skills for learners; learner responses must be transferrable from the classroom and function to provide goal attainment capabilities.

The simulator is a method for controlling complex situational variables, insuring the safety of the respondent, and developing skills to the level necessary to insure certain skills levels for the learner. The following excerpt by Gagne is alucid indication of the value of the simulator in teaching complex responses patterns:

> ...First of all, as has already been implied, a simulator attempts to represent a real situation

> in which operations are carried out. (By 'operations' is meant a set of events in which a man or men interact with machines or with their environment to bring about a particular result.) ...Secondly, in representing a real operational situation, a simulator provides its users with certain controls over that situation. It might be argued, in fact, that this characteristic constitutes the major difference between a simulator and the operational situation itself. The latter is usually, by definition, uncontrolled and subject to unpredictable variations; whereas the simulator provides for control (and often, planned variation) of these same aspects of the real situation . . .Thirdly, the simulator is deliberately designed to omit certain parts of the real operations' situation. . . .In all simulators, a greater or smaller portion of the operational situation is purposely omitted. . . (Gagne, 1965; pp. 225-26)

In each learning stage, a learning system should increasingly simulate the responses required for the next life stage. This is stated more formally below.

Assumption #1

> The Classroom as a Life Simulator:
>
> The classroom is most functional when used as a simulator for the development of responses that are transferrable to the home, community and next life stage.

Human Learning and Socialization: Though animal learning is basically controllable through objects (reinforcers) which reduce primary and secondary drives, this is not the case for

human learners beyond the first few months of human life, as the womb giving birth and support to human responses is not primarily physical but social. Human learning takes place, mainly in this analysis, as a consequence of events (intra-familial and social advantages) rather than through the ingestion of food and water or the avoidance of externally inflicted pain.

Assumption #2

The Human Learning Assumptions:

(a) Learning in humans occurs when a positive affect shift takes place following a response.

(b) Learning is assumed to have taken place when a pattern of responses is systematically modified so as to increase the probability of attaining pre-established goals.

(c) Human learning is facilitated when learners perceive themselves as achieving a required standard under conditions where there is a perceived probability of failure.

(d) Human learning is fundamentally linked to the social (rather than the material) consequences of a response.

(e) Material objects have learning value to produce positive affect only to the degree that they are perceived as indicators that some perceived social standard is being met.

(f) Learning takes place most efficiently under conditions where the perceived consequences of a response involve the attainment of goals perceived as important within a society in which the learner is a member.

(g) Learning systems increase in efficiency when learners perceive that the attainment of goals is tightly linked to upward shifts in the role and/or status of the learner in the society.

Motivation as Learned Behavior: Motivation is defined as the degree to which goal-directed responses are sustained before an individual shifts from the effort to reach a goal to some alternative behavior. The degree to which goal directed responses are maintained is held to be a function of prior goal achievement. Those who have learned to sustain responses which achieve goals learn to respond over extended periods of time; they become motivated for future goals. This outcome results from a learning system which: (1) provides goals of interest to the learner; (2) systematically increases the time and effort required to achieve goals; (3) insures a rich reward history for goal achievement over extended periods of time, and, (4) provides high probabilities of goal achievement when linked to active goal directed response patterns. These conditions generate motivated learners, in this analysis, regardless of the prior level of motivation.

Motivation can be systematically developed as an integral aspect of classroom progress by designing the system to provide a learning history where the anticipated gratification in goal achievement is perceived as outweighing the energy necessary to attain it. If Motivation (M) is conceived to be a vector consisting of willingness to expend energy (E) and a perceived goal (G), then the perceived value of G must always exceed the perceived cost of E. The learning system must be so designed that G>E.

Assumption #3

The Motivation and Self-Image Assumptions:

(a) Motivation is learnable; the first and most crucial product of a learning system is the development of learner motivation to achieve system goals.

(b) Humans in a social setting have a greater learning potential than humans learning in isolation: learning which improves social status produces an affective increment which increases the general level of learning efficiency.

(c) Learning systems which involve perceived upward status shifts for all learners, on the basis of progress within the system, result in improved feelings of self-worth, greater self-confidence, and increased motivation to perform.

(d) Involvement in educational materials will be facilitated to the degree that such learning is linked to role and status gains in a social context perceived as important to the learner's image of himself.

(e) Improved self-image occurs when the individual (1) shifts roles which indicate an increase in his status and importance as a group member and (2) is responded to by others as being instrumental for attainment of their goals.

(f) Evaluations of learner performance function to improve self-image and increase motivation under conditions where such evaluations are evidence to the learner of mastery rather than a threat to expose learner inadequacy.

Symbolic Skills: Our present social system provides rewards and offers upward mobility to those who have an extensive and precise language base. The minimum level necessary is the ability to deliver information by mouth or in print, and to comprehend verbal and printed information accurately. Minimal second level skills involve organizing information, planning,

scheduling, and describing relationships, and the ability to classify, develop procedures, forms, lay out work requirements, etc. At higher symbolic levels, there are requirements to generalize to the present from the past, using such things as documents or a wide variety of existing classification systems and morphologies, and to utilize this ability in skills which involve repairing of equipment, malfunction analysis, office administration, etc. Beyond this, there are requirements for developing and evolving new equipment, methods, procedures, and techniques across business, science and the supporting technologies. Such effort involves understanding of complex principles and concepts, either compressed into formulae or organized in an ever-changing, interlocking specialized jargon.

(1) In short, the ability to manipulate language with minimal distortion and to classify and conceptualize is the highest priority life requirement for adjustment to the imperatives of a technological meritocracy. The initial discrimination of textures, forms, colors, smells, distance, weights, etc., must quickly lead to identification of objects, events and persons and then to classification and generalization. The language code must be established as a precondition for the decoding of print which we call reading.

(2) Thus, the education of the young, whether from disadvantaged or typical homes, must focus on the development of an extensive vocabulary base so they may learn the value of classifactory and conceptual terms as a means of compressing information and exposing critical relationships.

However, the energy involved in developing an extended language base (including identificational, classificational and conceptual terms) will not be expended unless language

functions to produce goals more efficiently than non-language responses. The development of symbolic skills in a classroom context therefore requires that language be learned as a functional tool for achieving important perceived goals. To shift learners to the use of language, goals must be attainable with minimal delay and be perceived as relevant by the learner. Language linked energy will be expended only if word use is perceived as producing goals more efficiently than the existing response mode.

Assumption #4

The Response Pattern Shift Assumptions:

(a) Language learning will occur only to the degree that language produces learner goals with lower energy expenditure than non-language behaviors.

(b) Those classes of response which function most efficiently for the learner to achieve goals will displace less efficient responses in the response repertoire.

(c) Where the individual perceives himself to be a member of a social system, those behaviors and activities which result in perceived status gain will tend to displace competing responses.

(d) A classroom which operates on the basis of learner group norms will be more efficient than one where learner activity is an outcome of requirements based on authority.

(e) Where learners interact directly with each other in dyadic relationship, learning contingencies are more efficient.

(f) Learner attitudes on self-worth improve where learners perceive themselves as continuing to achieve learning goals under conditions where learning partners change frequently.

The preceding assumptions are specific to the Micro-Social Learning System. This pre-school system involves the development of the spectrum of skills necessary for adequate performance in an elementary school system.

The theoretical framework for Progressive Choice is presented below. While the theory is more comprehensive in application than its use for the resolution of pre-school problems, it is presented here at the broader theoretical level.

The Progressive Choice Positions:

The theoretical framework underlying the design and organization of the Micro-Social Learning System is termed The Progressive Choice Theory. This theoretical position, first explored in 1955, has been applied to the development of a variety of learning systems in education and in various technical learning areas. (Woolman, 1955, 1960, 1962, 1964).

Constantly Expanding Fields of Choice:

Learning is fundamentally linked to the control of choices to which the learner is exposed. Where the environment is very rich and stimulating, the number of choices is very large. Before learning has occurred, the probability of a correct choice will be very low in a highly stimulating learning environment. Learning systems must control the probability of a correct choice based on: previous learning history; kind of response required; number of choices offered; the kind of feedback given, etc. A Progressive Choice System provides new elements only on the basis of proven skills in making the correct choices for all previous elements and functional combinations. Learning takes place most efficiently when organized

into successively expanding fields of choice where mastery of a given choice field must occur before learning exposure to the next area becomes possible.

Within each successive choice field the learner chooses without constraint. As he demonstrates initiative and skills in attaining personal objectives independently within a given choice field, he moves to the next choice field and so on until he can attain any personal objective within the given domain. Ideally, on mastery of the final level, he could make any chain of choice (decisions) to attain whatever goals he might wish within the given informational and skill domain.

The Progressive Choice System involves: (1) analysis of all learning elements which are involved in making successful choices for total mastery; (2) organization of these learning elements into a network or Learning Lattice (Wcolman, 1962). These lattices are so arranged that successive elements can be learned individually and then combined with previous elements in a network of ascending conceptual or organizational complexity.

The Progressive Choice Assumptions:

(1) For learners to obtain gratification from responses they must perceive their learning task as offering a real probability of error.

(2) In organizing a learning system, the expected learner error level must be controlled to insure that success probabilities remain high (above .75) throughout learning to reduce frustration and avoidance reactions.

(3) Learning systems should be so designed that the perceived probabilities for failure are substantially greater than the actual probability of error.

(4) The greater the number of responses made which result in a positive affect shift by the learner, the greater the rate at which learning takes place.

The Sequential Hierarchy:

Learning is facilitated where the elements to be learned are ordered in such a fashion as to combine successive learning elements (LEs) in a mutually inclusive fashion. First LE_1 is learned to the criterion, then LE_2 then LE_{12} are combined, the LE_3 is learned individually and in combination and so on. At all times the learner is required to make choices to establish mastery and all materials are organized to emphasize function.

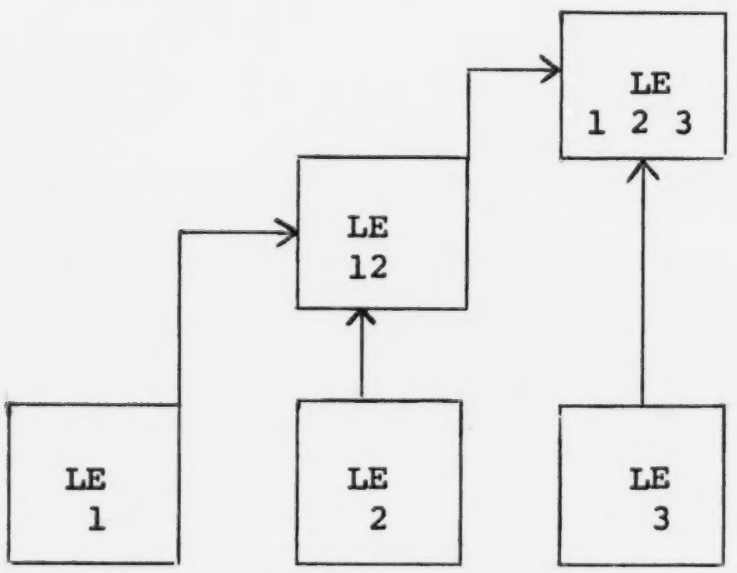


Diagram 1 shows that all materials to be learned are organized as mutually inclusive and subsumptive (LE_{12} and LE_2, $LE_{1, 2, 3}$ subsumes $LE_{1, 2}$ plus all base line cells).

The Sequential Assumption:

Learning complex materials to different levels of

abstraction and/or complexity is facilitated when the materials are pre-organized into a structure which provides for the learning of individual elements which are successively combined in a mutually inclusive subsumptive fashion.

In addition, there are certain rules of thumb in Progressive Choice Learning Systems which include such relationships as:

(1) Controls must be exercised over learner error probability at all points during learning.

(2) Tension levels which reach the anxiety threshold increase error rate and tend to produce mechanized and stereotyped responses. Efficient learning systems cannot exist under conditions of authority where punishment, favoritism, scolding, scapegoatism, etc., can occur.

(3) Irrelevant, digressive, aggressive, withdrawal and anti-social responses reduce learning efficiency and should be minimized within the learning context.

(4) Learning sequences should be so organized that learners continue to obtain gratification from adequate responses over extended time periods.

(5) Ideally, learning is complete when the learner can make all possible choices successfully to achieve personal goals. Freedom, similarly, is defined as the capability to make all choices necessary to obtain a personal goal. Freedom, in an educational sense, exists only where sufficient learning has occurred for the achievement of personal goals.

An assumptive network or theory should be capable of generating an infinite variety of learning systems. The controlling factor in developing a particular system is the philosophy of education which forms the ground in which the theory is set as the figure. The theory and philosophy, taken together, converge to establish the framework within which the educational learning system is imbedded. The beliefs and convictions of the system makers (beyond the theoretical assumptions) are vital elements in shaping the system through the use of the theory. If the theory is powerful, it can be used to produce conformists or individualists, sterile or expressive students, alienated or empathic persons. Theory is indifferent to whether students learn by rote or solve problems by individual initiative and imagination. An effective learning theory is independent of the kind of learning which takes place. The theory is the vehicle; what is done with it is the highway selected by those who possess the theory. The educational philosophy forms the avenue and goals viewed as important to the learning system builders. The philosophy which controls the use of a theory must be made explicit to the system staff used for designing the prototype. Without the underlying philosophy, the staff would lack a map which defines the objectives and functions underlying their effort.

THE PHILOSOPHIC POSITION

If quality of manpower is the fundamental national resource, then improvement of the quality of our manpower resources must have the highest national priority. It may be far more important from the viewpoint of national policy and national survival to develop effective pre-schools rather than A-Bombs, SST's or space voyagers. If we accept the reasonable thesis that adult behaviors are strongly influenced by experiences during the first six years of life, then it may well be that our social survival depends on the development of optimal methods of early education. Pollution, drugs, crime, alcoholism, welfare, and riots, grip the attention of newsmen because they provide immediate shock, personalities, and brief moments of high drama suited to modern media coverage. However, these adult behaviors indicate that a substantial proportion of American adults feel themselves to be inadequate to meet adult problems. Various forms of escape such as drugs, alcohol, viewing of media, etc., are utilized as a means of minimizing anxieties and apprehensions. Crime is essentially characterized by: (1) failure to maintain emotional control under conditions of stress; and, (2) a requirement for property in the absence of the life skills and/or credentials necessary to purchase the objects desired. In essence, crime may be defined as the failure to limit responses within the boundaries defined (by law) as necessary to protect the rights of others. It is essentially compulsive in the sense that the individual feels compelled to perform an act beyond the limits of the allowable response spectrum. Possible punishment does not deter because the respondent is operating in immediate time to satisfy an immediate overriding and compelling need. Our increases in escapists and in crime stem from the inadequate preparation to meet the demands of an individualistic technocracy. The church, the community, as well as many homes, no longer provide the means of establishing codes of behavior, character, and moral commitment -- rubrics that indicate well organized, socialized responses and well-defined response boundaries. In addition, where skills have not been developed in planning

future goals and in moving through sub-goals, tension is reduced in immediate time through physical agents (such as drugs and alcohol) acting out, violence, sensual and/or sexual release, and/or retreat into the vast panorama of escapist spectator activities on which large industries have been built.

Other societal problems are less in the spotlight. For example, in industry and even in universities, turnover rates are high; employees are uncommitted and show increasingly higher rates of absenteeism and job mobility. Job training programs founder whether supported by the government or industry. The fact is that the difficulties involved in training adults are now becoming apparent. The stability of adult perceptions, habits, language base, goal acquisition skills, task involvement, and responses to satisy immediate needs are based on ancient, deeply organized habits, all of which have been rationalized into attitudes and beliefs. When an adult personality is formed, modification of even limited pieces of behavior is enormously time-consuming, expensive, and even then, often shortlived.

Behavioral modifiability is limited by the history of prior experience. Experiences which result in anxieties restrict responses and limit the response spectrum and because anxieties are cumulative, the number and kind of available responses tend to become increasingly limited with increasing age. Over time, more and more personalities and events become associated with apprehension, pain, and frustration. Avoidance of these areas to reduce anxiety increasingly limits behaviors. Our national manpower programs, to become even modestly effective, must go far beyond job skill and literacy training. Much more sopisticated learning systems will be required to produce the perceptual and behavioral changes that lead to genuine upward mobility and substantial contributions to the tax base. The development of basic life skills at an early age is a simple and straightforward solution to the national manpower problem.

Future problems involving our manpower pool, crime, escapist behaviors, etc., would be reduced if learning systems

for pre-school children would result in: (1) deep satisfactions and skills in the area of language; (2) enjoyment in working alone or with others to achieve short and long-range goals; (3) skills in controlling impulsive and aggressive behavior; and, (4) ability to tolerate present frustration to achieve gratification in the future.

Educational learning systems, which can provide such deeply habituated activity patterns would result in elementary and high school students who would be: (1) competent to perform their academic tasks; (2) able to obtain some level of satisfaction (rather than anxieties) in the classroom context; and, (3) able to enter the job market, before or after college, with a much broader range of skills, fewer anxieties, and a better self-image. When such persons enter their adult years, their gratifications should be linked to social effectiveness, achievement of goals, and meeting personal standards that are within the boundaries of a personal and defined ethical system. Education, to the degree that it provides skills in achieving personal goals, is the essential prerequisite of freedom.

Personal freedom is a political given in an individualistic, democratic society. Trapped by limitations of language, caroming in response to emotional needs like billiard balls, unable to live or work harmoniously in a sustained fashion, and lacking useful skills on the job market, large numbers of Americans are paralyzed, impotent and frightened. They react to forces impinging on them but lack the simple fundamental property of freedom, freedom to decide on one's own life goals and the personal resources to work towards their achievement.

Allport (1955) makes this essential linkage between education and freedom very pointedly in the following passage:

> . . .Similarly, relative freedom, we know, depends upon the individual's possession of multiple possibilities for behavior. To state the point paradoxically, a person who harbors many determining tendencies in his neuropsychic system is freer

> than a person who harbors few. Thus a person having only one skill, knowing only one solution, has only one degree of freedom. On the other hand, a person widely experienced and knowing many courses of conduct has many more degrees of freedom. It is in this sense that the broadly educated man is freer than the man narrowly trained . . . (pp. 84-85)

Thus education's fundamental value in a democratic society is the development of those skills and capabilities necessary for some degree of upward mobility. Education must prepare its graduates to be willing to invest their energies into the future with a reasonable probability of success. Effective educational systems are social instruments which insure that adults can enjoy the fruits of their society. To the degree that men are powerless to choose, they lack freedom. Efficient learning systems should provide those skills ultimately necessary to make appropriate choices and judgments, and the stamina and flexibility required to attain major life goals. Failure to provide these skills violate the essence of educational responsibility.

In addition to developing personal independence and goal attainment skills, this philosophy holds that educational systems have the responsibility to provide those capabilities required for participation in the society as a citizen, community member and family member. Further, an effective educational system should be capable of developing language skills, social interaction skills, self-control and motivation, to the degree that such skills are required for effective adult performance. Educational systems at the pre-school level should possess the resources to overcome any handicaps imposed by the home and community. By the time of entry into the elementary school system, the pre-school pupil's skill repertoire, behavioral control and ability to adapt should be sufficient to insure acceptable performance. On completion of the entire educational system, graduates should be equipped with the means to meet their general adult responsibilities and also maintain some degree of upward mobility based on their own decisions.

The Learning System Objectives

The theory combined with the philosophic framework comprise the assumptive framework and set the stage for establishing the objectives of the system. In establishing objectives, in the interest of economy of time, money and personnel, non-essential and redundant skills should be avoided. Objectives of learning systems are strongly affected by other social institutions; however, where these institutions fail to provide certain kinds of understanding, such as basic social awareness, the educational system is obligated, as an adult readiness system, to do so.

A pre-school system should move across all socioeconomic levels, have no barriers based on familial or community handicaps in language or behavior, and be indifferent to variations in color, sex and age. Further, it should be capable of accommodating to sharp differences in language skills and emotional states.

The general objectives of a pre-school learning system are, in this view:

(1) To insure the spectrum of behaviors and skills necessary for effective performance in an elementary school setting.

(2) To provide a basic set of behaviors and skills which will facilitate adaptation and effective performance of individuals in the home and community.

The General Terminal Objective:

The terminal objective of the learning system should be a broad statement which embraces its purpose and the range

and level of the skills required, such as:

> To provide all the skills necessary for pre-school children with and without cultural and/or language handicaps to perform effectively at the first grade level, despite the substantial variation in school administrative procedures, curriculum, and differences in style, manner and expectancies in the elementary school setting.

The Pre-school Terminal Objectives:

These terminal objectives reflect those key aspects of behavior which the system model should provide to meet its own goals. In this writer's view, these objectives should be specified at considerably higher levels than any given situation might require, as the children will be distributed across a broad band of schools and teachers. The system's learning requirements should cover those response requirements which all learners can be expected to face across all first grades. In addition, the system should be designed to develop habits of action which extend beyond the first grade so they will not be of limited value. The following system objectives were employed in developing the Vineland Center:

Language Objectives:

(a) Develop a language base sufficient to meet the range of performance required in first grade, the home and the community, that is, a capability to independently extend the language outside of the classroom learning context (2,000 functionally useful words);

(b) Develop reading skills to avoid dependence on mouth to ear communication as the basis for language growth (300 words);

(c) Develop take-home materials to produce social interactions in home and community contexts specifically related to language expansion;

(d) Organized classroom activities which give value to the functional meanings of terms used in the home and community.

(e) Train parents in the learning system so they can facilitate the improvisation of related activities in the home to increase the rate of language growth.

Social Interaction Objectives: Develop skills in social interaction, such that learners will:

(a) Actively assist others in their mutual interest;

(b) Increase the rate of verbal exchange to use their new terms;

(c) Develop skills in improvising activities which can be done best on a cooperative basis;

(d) Use social interaction as a means of shifting roles to improve their self-image;

(e) Use social interaction as a means of avoiding the development of social barriers related to differences in sex, language, color, age, etc.;

(f) Use social interaction as a means of

transferring information from higher skill to lower skill learners;

(g) Use social interaction as a means of reducing anti-social behaviors.

Motivational and Task Involvement Objectives:

(a) To develop in students the capability to maintain response patterns to a given task covering a period of one hour;

(b) Develop a high rate of self-initiated responses to printed material;

(c) Develop personal involvement in Center learning tasks, so that learning itself ranks higher in producing personal gratification than do motoric, aggressive, and avoidance behaviors;

(d) Develop satisfactions in performing self-initiated expressive activities which extend beyond what has been formally presented in the learning system;

(e) Provide a broad range of learning activities which are self-initiated, express learner preference and do not require imposition by the teacher;

(f) Provide situations which develop both immediate and delayed rewards to permit learners to project into future time, develop frustration tolerance, and learn planning skills for attaining rewards in the future.

CRITERIA AND SPECIFICATIONS

The criteria for generating specifications for the prototype serve as a guide to staff to plan the operational prototype. Criteria are written in fairly concrete terms and conform to the theory, philosophy and objectives; they function as an action tool to guide staff and should not unduly limit imagination and initiative.

The following illustrate the kind of criteria employed by the writer in setting up system specifications:

(1) The system will emphasize the development of responses and deemphasize stimulus enrichment. The environment is conceived as a response generating system.

(2) There will be a minimum level of non-relevant stimulation which could intrude or distract learners from the given learning task.

(3) Responses will be learned across a broad spectrum. Language, for example, will include speech comprehension and reading; however, competing responses that reduce learning rates, such as those involving aggression, withdrawal, and those behaviors which prevent others from learning, are to be reduced in rate or eliminated;

(4) Responses to others should be mutually supportive and cooperative, and indicate benefits from shared efforts while providing freedom to respond as an individual;

(5) Responses will provide learners with large numbers of opportunities for immediate perceived success;

(6) Major goals and sub-goals will extend into future time and provide delayed goal achievement in a rhythm of increasing time distance between goals.

The Classroom:

(1) The learners will interact with each other to the extent possible.

(2) The response rate for each learner should ultimately reach fifty recorded responses per hour.

(3) There will be no punishment or imposed pressure from adults.

(4) The classroom will have two levels of structure, both in terms of physical arrangement and task performances:

(a) A fairly high degree of structure for social interaction and language learning; and,

(b) No apparent structure for expressive and creative activities

(5) The teacher will be responsible for insuring that methods are followed. The teacher will be the planner, organizer and administrator of all classroom activities. She will control the flow of activity, direct the aides and insure that the learning system paradigm is followed. The

teacher will decide whether the children have reached the skill level required to move on to additional learning goals. She will not be limited to the materials contained in the system and will be encouraged to improvise supplementary materials which are consistent with the learning system.

(6) The system will be dominated by learning rather than teaching. The interaction between learners will be the dominant process involved in producing content and social interaction skills.

The Learning Materials:

(1) Since learners will be free to move and talk among themselves, the learning materials must provide sufficient emotional satisfactions to engage in available alternative stimulation.

(2) All learning materials will be designed to interlock, to be cumulative and mutually inclusive. Each new informational element will be learned by itself and in combination (where applicable) with all previously learned materials; new materials will tend to subsume and be supported by previous learning. (Note apparent inconsistency with Bijou's fifth assumption above).

(3) All learning materials will be functional. If the learning element is the term "eye," the learner must know that it is the "seeing" part of the body, that there are two eyes, and that they are spaced above the nose, etc. The functional use of terms will provide learners with language as a tool for achieving satisfactions and attaining goals. Language will be perceived as a method of obtaining satisfactions which are both more precise and less

energy demanding than aggressive, avoidance, obstructive and other alternative behaviors.

(4) All learning materials will be so designed that learners can obtain a 100% criterion of mastery. Checks of learner skill level will occur frequently and take place only after skills have been learned. The checks will function as proof of mastery as perceived by the learner and not as a teacher's evaluation of the learner's performance level.

The Learners:

(1) The system will be designed to permit children to learn and act independently and freely. Learners will be minimally subject to adults for their progress, achievement related satisfactions, and opportunities to learn.

(2) The settings at which children work will be designed to facilitate performance and social interaction. Equipment will be built to make it easier and more natural to work as partners in a mutual learning task than to act individually.

(3) The classroom will be laid out so that progressive mastery of the learning materials is translated into progress in physical space; the classroom, in essence, is an upwardly mobile social system where progress is perceived as upward social mobility in a society in which learners view themselves as members.

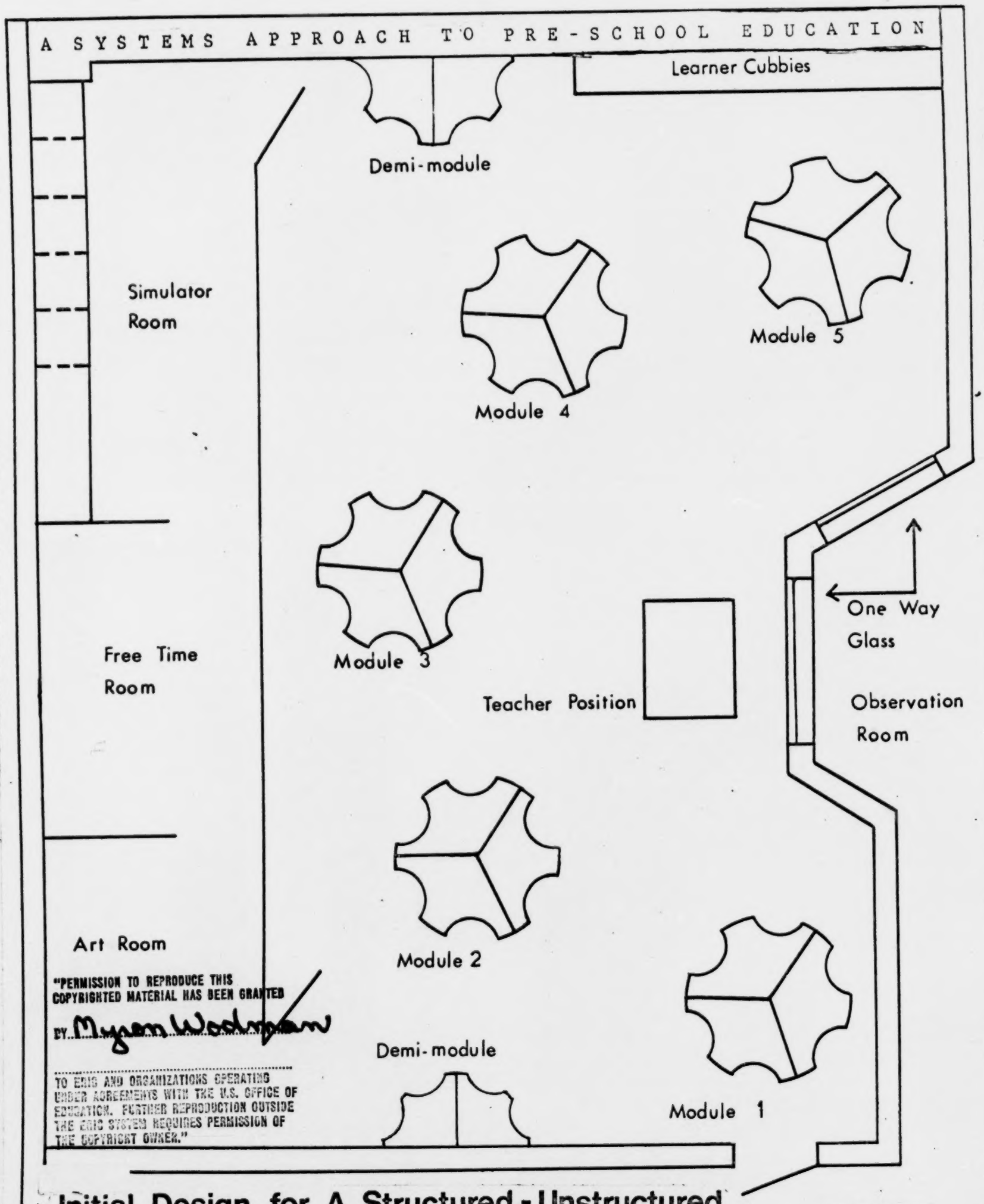
Specifying the System

Converting system criteria into proper system specifications is a complex, elaborate and time consuming task, even for highly effective systems teams. The kinds of products which are produced in attempting to meet the criteria are illustrated by Figures 4, 5, and 6. These represent an extremely limited but representative fraction of the type of materials developed to detail the requirements for the prototype based on the criteria.

Figure 4 presents one version of the structured-unstructured classroom learning space in specification form. It shows five learning modules each of which seat six children. The modules are split into three sections so that the children can interact in pairs. The module sequence provides the upward mobility in the classroom. Moving from one module to the next depends on mastery of a given set of learning materials to a 100% criterion by children working in pairs. Children supposedly perceive the successive sequence of movement in learning to perform effectively in the system.

We realized that there were two major risks involved in this plan: (1) perhaps children would not be able to learn to use the learning materials working in pairs largely independent of the teacher; and, (2) perhaps children would fail to perceive that the classroom pattern, their skills in mastering materials and their movement from module to module were in a triple linkage. As the learning system hinges on independent learning by partner pairs and perceived upward social mobility linked to mastery, the decision to go ahead with the classroom design was crucial to the success or failure of the system.

Figure 4 shows two additional modules (demi-modules) designed for four children each, hugging the left and right walls. The teacher occupies a central position. The Life Simulator area, shown at the bottom, provides room for a large variety of self-initiated, expressive activities whereas the modular section provides a rather systematic learner flow with



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Initial Design for A Structured - Unstructured Micro-Social Classroom

FIGURE IV

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children (though free not to perform work) learning and progressing at their own rate, from module to module. On the upper left are cubbies designed to hold the learning materials of individual children, since the modules are used by two classes of learners each day. (For practical reasons, these modules were later laid out in a more linear pattern).

Language learning was basic to the learning system specifications, as noted above under "Language Objectives." The language materials were organized into seven language pools or micro-languages. These were: (1) Partnering, (2) Forms and Colors, (3) Body Parts, (4) Food, (5) Household Objects and Events, (6) Nature, (7) The Classroom and the Community and (8) Other Lands. (See Figure 5, p. 241.)

The initial language, partnering, requires the children to learn the signals or ideographs which permits them to work together as dyadic pairs while learning the materials. The language areas are mutually inclusive; as one moves out, each successive micro-language includes the language previously learned.

The initial area to be learned is "Common Forms" (lines, straight, curved, vertical and horizontal lines). These are combined into squares, rectangles, triangles, circles, etc., and are used as the basis for initial activities. All terms are learned functionally and are related to the variety of activities which provide opportunities to use newly acquired language terms in the course of constructions, cut-outs, and drawings.

For each micro-language there is a story and at least one workbook. The storybook is designed to: (1) dramatically present the terms in each micro-language; (2) provide a means for children who speak in a dialect or in Spanish to hear the goal words correctly sounded in context; and, (3) provide a reliable method to obtain responses from each learner to properly sound each of the goal words.

The language of color is included to provide language terms which would be perceived as functional in construction

and coloring activities and to increase individuality and expression in these activities. Designation and use of color, in effect, provides a simple micro-language which dramatizes activities quickly. Color also provides basic terms for selection, description, games, songs and communication. Note that the language pools move from the self (perception) outwards to "Other Lands" to provide learning terms such as igloo, pagoda and polar bear. Figure 5 represents the micro-languages as a series of concentric circles. Each concentric circle is inclusive, continuing and extending the language base previously mastered.

The terms in each micro-language focus on functional value rather than frequency counts. The intent was to organize a body of basic terms that offer a wide range of concrete, descriptive terms, classificational terms, and concepts so that the pre-school setting could be generalized and expanded to the home and community. Each new term must be learned at five levels. At the first level, the term is a "goal word" in a story. The remaining four levels of the term are to be work-books synchronized to the story line. Two learners work together as partners through the four levels. Signals (ideographs) in the workbooks are intended to permit the children to work together with almost no teacher intervention.

The organization of the five levels for learning each new word (goal-word) is presented in Figure 6, The Pedagogical Lattice for Functional Meaning. The five learning levels are termed: Contextual Association, Discrimination, Identification, Functional Association, and Functional Meaning. At the Contextual Association Level, the learner is merely required to sound the term correctly based on the teacher's pronunciation and then to point to the illustration in the teacher's storybook (Cell B-3). At the second level (Discrimination), the learner is in his own workbook and working with a partner and his responses are limited to selecting and matching forms and illustrations which are associated with the meaning of a term he had voiced correctly at the lower level. (See p. 243.)

A SYSTEMS APPROACH TO PRE-SCHOOL EDUCATION

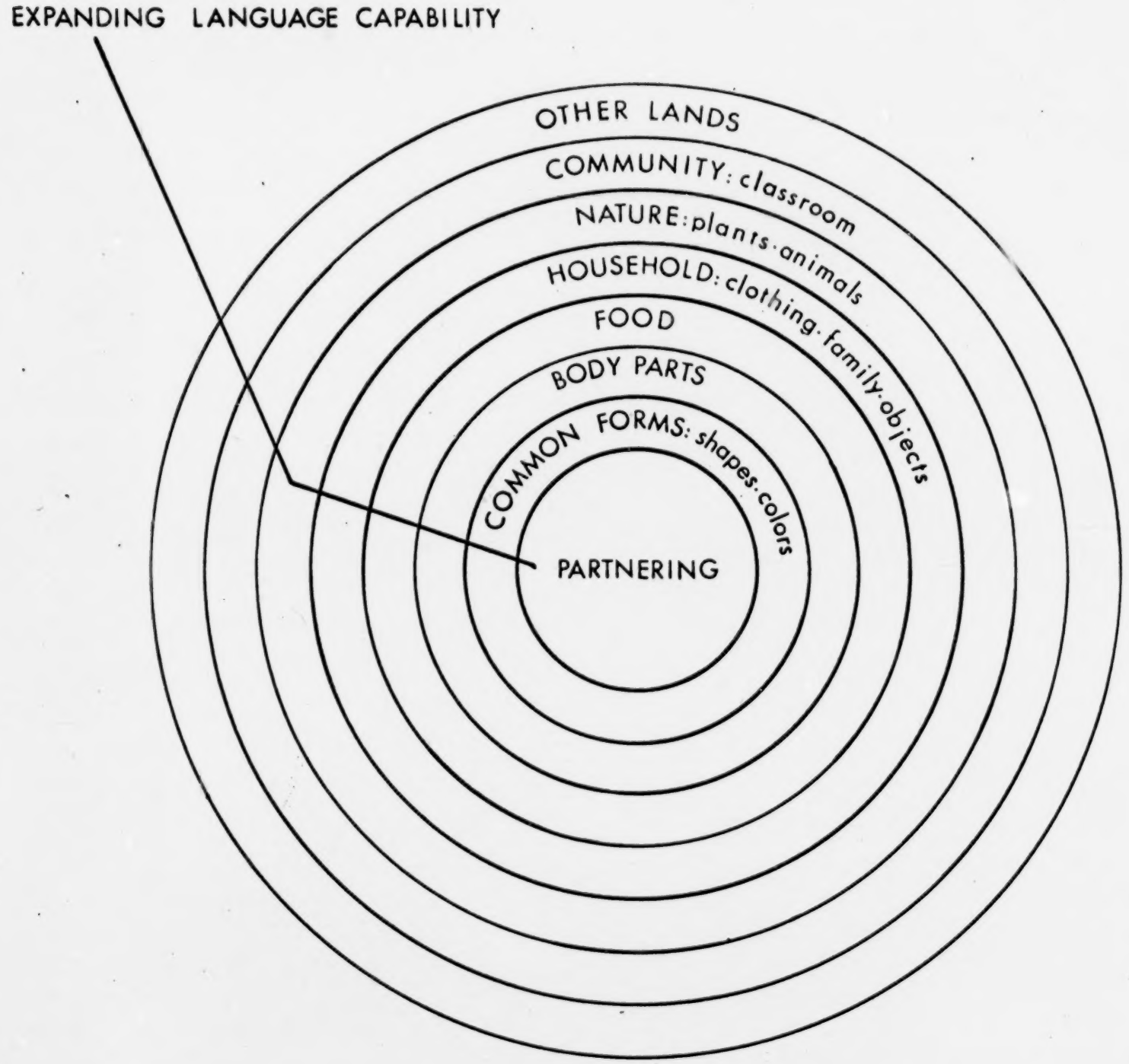

FIGURE V

SUCCESSIVE SPEECH POOLS

At the next higher level (identification) the learner joins the two lower levels (Discrimination and Contextual Association). He makes the appropriate word sound which he has learned from Contextual Association upon seeing the appropriate illustration or form he has learned from the Discrimination Level. When he can give the correct term on seeing the form and select the correct form on hearing the term, he has identified the object. In addition, using ideographic signals he verbally identifies all terms previously learned on seeing a variety of forms in his work-book.

All terms are to be learned functionally, e.g., the "eye" is used for "seeing", the elbow "bends." The Functional Association Level requires that all learners understand why a term they know at the Identification Level is important to them. Functional values are to be shown in special illustrations and presented by the teacher or aide to set up the three-way linkage (illustration-identification-and function).

At the Functional Meaning Level, two partners are to establish that each knows the correct name for the objects illustrated and can tell what the object did or its use value.

At the Functional Meaning Level (top right hand cell), the learner is required to designate the word which would be most appropriate for accomplishing something within an illustration designed for that purpose. He must analyze the situation, determine what happens and designate the appropriate term and the function being performed in the action context. These tasks increase in complexity to develop items of increasing difficulty. Thus, for any one goal word at the Contextual Association Level there is at least one functional related term to be learned at the fourth and fifth levels of meaning.

Life Simulator Space activities are planned to be cross-coded to the terms learned so that the functions can be actualized in a much more realistic and concrete setting. The

PEDAGOGICAL LATTICE FOR VERBAL FUNCTIONAL MEANING

FIGURE VI

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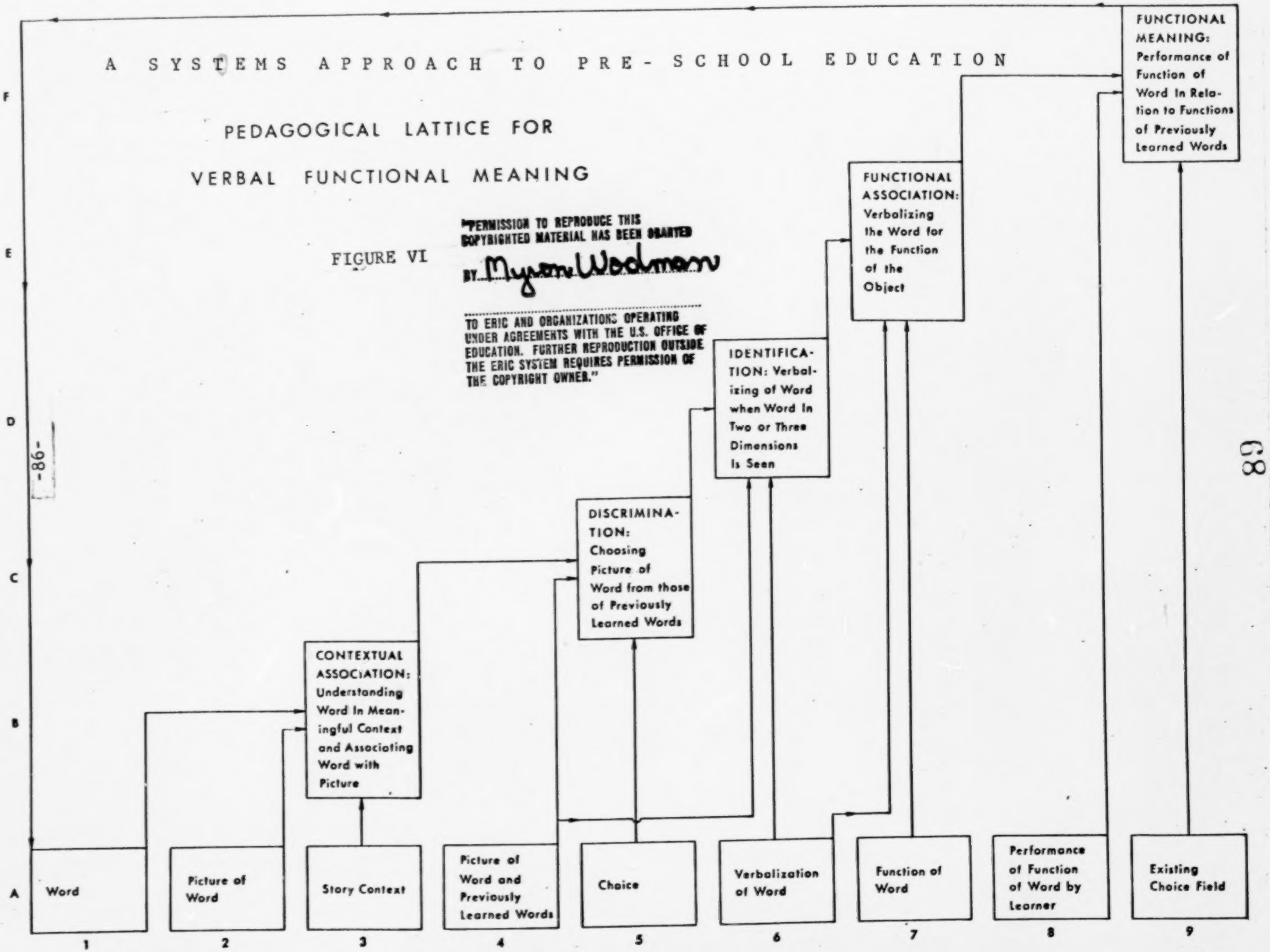

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Life Simulator Room activities are designed to be simple, quickly completed, and to result in a tangible and concrete construction. It was anticipated that these linked Simulator Space activities would give the children an opportunity to work individually or in groups, see the new terms and their functions in a realistic goal achieving context, and provide the basis for adding new terms in a play activity setting. For example, after learning linear forms and colors, an activity would involve their assembly into a figure such as a robot, house, car, etc. These new terms, cluster words, function as descriptors for a total integrating effort which describes a total activity cross-linked to terms learned in the work-books.

At a theoretical level, it is essential that the terms in each micro-language be presented in orderly and mutually inclusive sequences. It is also important that the sequence move from concrete (sensorily available) terms, to classificational terms and ultimately to conceptual (multiple class) terms. The stories (for Contextual Association) and the learner workbooks (for the other four levels), are planned and controlled through the use of lattices. A Lattice for Body Parts has also been designed as a method of organizing body terms into a sequence such that each successive level would be subsumptive and mutually inclusive. In the course of actual implementation, lattices may be fractionated into finer details or modified as required; however, their use was important in providing a pre-planned structure laying out the sequence in which all terms and functions would be introduced independent of the particular team member performing the task.

THE OPERATIONAL STAGE

The problems involved in translating the specifications into an actualized operational system may be briefly described, though the actual process is both complex and time consuming. The basic problem is to assemble a staff which will: (1) learn and conform to criteria and specifications; (2) function as a team capable of synchronizing their individual efforts into a cohesive whole; (3) work with imagination, ingenuity and understanding under the various restraints imposed; and, (4) have the flexibility to shift from task to task to conform with the specification requirements as they change for various components.

The Vineland classroom in operational use presents a varied scene. Some children may be at the Contextual Association Level, others may be working independently at their modules, and still others are in The Life Simulator Space.

The partnering interactions are linked to workbooks and contribute to the system in several ways to:

(1) Increase the rate of learner response sharply;

(2) Free the teachers and aides to focus on problems of learning, classroom flow, evaluation and behavior control;

(3) Provide social interactional skills based on mutual success in joint tasks;

(4) Provide a basis for movement from module to module;

(5) Set up opportunities to verbalize and utilize language terms;

(6) Provide the basis for shifting social roles based on level of mastery;

(7) Become the basis for rotating all learners with each other to eliminate cliques and/or isolates;

(8) Generate the language base which can then be used functionally in activities in The Life Simulator Space and the home and community.

In one sense, the entire learning system hinged on the partnering concept, since it was based on the belief that learning efficiency, socialization value, and behavioral control outcomes would be substantially reduced without the independent learner interaction involved in partnering. It soon became apparent that the children (even the youngest) had no difficulty in learning this new "game." Within a month, the majority of the children were responding to the partnering ideographic symbols with awareness of their meaning, though misinterpretations did occur frequently. By the end of the third month, the classes routinely used the method as planned with little discernible difficulty.

Teacher Training: No effort was made during the Micro-Social training of teachers to persuade the staff assigned by the school system that this new method would be superior to existing methods. Teachers were initially skeptical and distant. However, despite doubts about the partnering concept, the huge number of terms, the lack of punishment or discipline, the peculiar look of the modules, the goldfish feeling conveyed by the observation rooms and many more reservations, the teachers learned the methods and techniques, studied and understood (though often they wouldn't accept) the rationale for the system. In brief, though the teachers lacked faith in the approach, each worked and learned how to perform the teaching job in the classroom. In three weeks of training (including one week in the classroom) they developed a good verbal command of everything we thought they should know; however, they were unsure of themselves in the classroom context.

From our experience staff training should cover the following:

(1) Optimal methods of teacher activity in the classroom;

(2) Techniques for using special materials and equipment; social interaction and behavior control techniques, etc.

(3) A specific text or guide for covering all aspects of the method involved in the classroom context.

(4) Opportunities to observe and critique teachers in action in the classroom and relate these to the teacher training materials.

(5) Free discussion sessions where the value or lack of value of the new system can be vigorously and candidly discussed.

(6) Opportunities to work in the classroom in the roles of parent-aide, aide, and teacher to understand different role requirements.

(7) Structured discussions covering vital aspects of the new method.

(8) Case studies designed to involve "best choices" under conditions where no pat system solution is possible.

The in-service training of staff should be intensive at the outset. Steps must be taken to minimize the forming of initial habits which violate learning system procedures. This intensive training and in-service period should not exceed four months, after which the number of meetings should be sharply reduced. Where teachers are unable to accommodate to the learning system approach, they should be free to return to their previous positions. Conversely, if teachers continue to

use incorrect methods after initial training, intensive in-service training should be maintained.

Teacher Selection: To the extent possible, teachers should not be selected on the basis of special criteria. A pre-school system, with an effective training program and a good in-service training system, should be able to train and use a high proportion of the teachers sent by a public school. The alternative is to compete for some special category of personnel, often in very short supply. A pre-school system associated with a public school produces minimal problems if it accepts those teachers (certified or not) who are assigned to it. Under such an arrangment, however, it is important that teachers be able to leave the pre-school without prejudice on their simple and unsupported request.

Teacher-aides are vital to the success of a pre-school system and are readily recruited from the community. If possible, it is often best to locate teacher-aides whose children are students in the Learning System. If a substantial number of children do not speak English, bilingual teacher-aides can be invaluable, not only in the classroom, but also to interpret at meetings, to translate take-home circulars, speak on the radio, and to explain the purposes and methods to the non-English-speaking community directly in the homes. Aide training should overlap completely with teacher training wherever possible to develop understanding and the range of skills required. Aides should participate in at least one in-service training session per week and, if funding permits, in all sessions. In the classroom, of course, the teacher has the responsibility to insure the fidelity of the system; well-trained aides who understand the system simplify the teacher's problems considerably.

In addition to the wide variety of specific, pre-school systems related materials that must be developed, there must be administrative support accompanied by various forms and procedures. Where an innovation system is linked to other organizations, administration is complicated by relationships with

the school system and funding agency. Staff morale can be affected by skepticism and uncertainty, particularly if teachers are recruited from the on-going school system in the same community. Problems of added workload, failure of school administrators to recognize special circumstances, communication gaps, and slights -- real or imagined from non-system professional staff, parents and community leaders, etc. -- produce added complications which require considerable energy and occasional finesse in maintaining good teacher and aide morale. The Superintendent of the host system, Board of Education members, higher level school functionaries and teachers in the host system should be oriented to the purposes, objectives, methods, materials and equipment whenever possible to minimize misunderstanding and conjecture.

Teacher involvement in both the prototype learning system and the normal chores of the classroom is vitally related to the fidelity of the system itself. Teachers are important in helping to solve the following kinds of problems which occur in making an innovative system function efficiently:

(1) Differences between the operational system and the system as initially designed which occurs through failures in training, misinterpretations, availability of materials, supervisory and/or staff errors, perseveration of old teaching habits, etc. These simple discrepancies must be located and corrected before they become crystallized into the operation.

(2) Situations where the operational system is conforming to the specifications but there are problems in terms of learner performance, e.g. children become confused or disinterested.

(3) The materials and methods function as planned, but there are typographical errors, misplaced pages, missing symbols, confusing illustrations, unforseen secondary connotations in language terms, etc., which involve locating errors within the minutiae of the learning system.

(4) The system is functioning as planned, but imaginative and resourceful staff familiar with the method, objectives and approach make suggestions which are consistent with the method and enrich it, based on their classroom experience and their intimate moment-to-moment awareness.

The Operational Pre-Tests: Objective arms-length evaluation of key base-line data was considered a necessity by the funding agency and the Vineland program. The funding agency was to make the arrangements using psychologists of their choice. The initial pre-tests of the children were (1) Wechsler Intelligence Scale for Children (WISC); (2) The Peabody Language Test; and (3) The Goodenough Draw a Man. Due to problems in coordination, testing began after the center's opening. It was considered more feasible to have the children enrolled during pretesting even though the pre-test scores would be confounded by whatever learning took place during that period. This discussion was also viewed as a conservative testing posture, as presumably these base-line scores would be increased to some unknown extent during this initial period. It was assumed that score differences on the follow-up tests would tend to be reduced in comparison to those that would have been obtained on the pre-tests before entry. Nevertheless, the means were quite low (median WISC was 71.8 for N = 117). Also after testing only a fraction of the Control group, their testing was discontinued abruptly and without notification as the importance of this procedure was not fully

appreciated outside of the project itself. This slip-up in obtaining the total requested Control data emphasizes the absolute necessity (discussed at some length in a later section) for erecting an external, specialized and highly sophisticated evaluation superstructure which operates to compare all pre-school learning systems using measures which lack at least some of the defects of those in current use.

The first interim tests covering the first six months of project operation have been given to a restricted random sample of the children and are now being analyzed. Median score differences appear to be somewhat greater than anticipated.

The Middle-Class Children: The first genuine evidence of the staff's positive reaction to the program was not in the form of ratings, discussions, or recommendations. Rather, about three months after operation began, teachers, aides and their respective husbands forcefully and formally requested that their own children not be excluded on the basis of their higher income levels. Since it was felt that these children would increase the skill range and be catalytic in a variety of ways, their inclusion was authorized.

EVALUATING AND MEASURING LEARNING SYSTEMS

The only necessary condition for an effective system is that it result in the kind of output behaviors required. If there were a choice between theoretically based methods, one of which delivers a narrow band of skills whereas the other delivers a broad spectrum to the same level, the obvious choice would be to favor the system which generated the greatest range of output learner skills. Further if an eclectic, non-theoretical system delivered a stronger output than one based on theory, the eclectic system should prevail. Systems for learners must provide measurable results.

The claims of eclectics, developmentalists and theoreticians must be tested against the hard realities of learner capabilities. The efficiency of systems is not resolvable in journals, seminars, colloquia or regulations. Evaluation of learning system effectiveness must be independent of partisan claims. The consequences of a learning system, properly evaluated, should offer no refuge in theory, authority, or rhetoric.

Learning systems are useful to the degree that they: (1) predictably increase the rate of learning, retention, and appropriate knowledges and skills; (2) deal with the problem of total human beings (rather than micro-behaviors attained in limited time frames); (3) increase skills in making choices, judgments, and decisions related to life itself; (4) reduce impulsive and aggressive behaviors where these restrict learning opportunities; (5) provide skills in interacting effectively with peers and adults; (6) substantively increase the proportion of children who satisfy elementary school standards, and, (7) reduce the number of children who are unable to respond within the limits of institutional regulations and public laws.

Measuring and Evaluating Learning Systems: There are three basic considerations involved in the measurement and

evaluation of a Learning System:

(1) The System Fidelity Evaluations;

These evaluations concern the degree to which the system prototype operates in accordance with pre-existing specifications. System fidelity evaluation is directly concerned with locating areas of system discrepancy. These evaluations are directed to insuring that the materials, equipment, methods and procedures in use are as consistent as possible with initial plans and specifications.

(2) The Individual Criterion Measures;

These are measures of learner performance which directly reflect the system objectives. If the system was designed to increase language skills and social-interaction skills then the battery of criterion measures should provide successive sets of measures from the outset of the project, over time, that yield a basis for evaluating the degree to which the specific objectives of the system were attained.

(3) The Total System Output Measures;

These are measures of the total capacity of the system. These are not limited to the specific objectives of a particular learning system but are designed to provide a basis for comparison between learning systems which may have differing objectives.

The Fidelity Evaluation Approach:

These measures concern the degree of consonance with

specifications and are primarily of value to the system designer. The measures form the basis for change to minimize deviations from operation of the system as initially planned.

Staff as an Information Resource: The teacher and aides have the most intimate and direct contact with the learning system. During the Operational Prototype their classroom experience can and should be utilized to uncover system discrepancies. This requires the following:

(1) The teaching staff must be sensitive and sympathetic to the objectives, methods and techniques used in the project.

(2) Staff must be able to verbalize the rationale for inclusion of given methods, materials and equipment and also possess the verbal skills to pin-point any areas of deficiency in the actual classroom activity.

(3) Sufficient rapport and confidence in system staff to provide objective and candid accounts of system problems for the record, even under circumstances where staff members' own behaviors are involved.

(4) Maintenance of a log of critical class-room incidents which affect system objectives.

(5) Surveillance and detailing of errors, confusing terms and illustrations, etc., in learning materials.

(6) Attendance of systems staff meetings, formulating critiques and otherwise serving as a resource to reflect the practical problems of the classroom.

(7) Making recommendations individually and/or collectively to improve system functioning consistent with the system frame of reference.

(8) Maintaining as standardized a pattern of activity as possible across class-rooms, making certain that new system modifications are adapted into all class-rooms in as similar a way as possible.

(9) Completion of required data collection involving ratings of (a) individual children; (b) adequacy of various aspects of the learning system; and (c) personal attitudes.

(10) Observing actual teaching activities and relating to system methods and procedures as required.

Rate of Coverage Measures: In those learning systems where there is an established framework or sequence of learner activities, some assessment measures must be adopted. For example, if there are a substantial number of work-books, the specification of completion dates for each successive work-book provides an important index of rate of learner motion. Should the rate of work-book coverage measure be used, it is important that procedures exist which insure that children have mastery of work-book materials before proceeding forward. Checks of level of mastery should occur frequently (one or two per day); rate of motion and mastery of learning materials must be tightly linked or the rate measure becomes a meaningless index.

The measures of rate can be broken down and scored in terms of pages covered per learner per month or even responses per learner per hour. The use of the page as a unit of analysis presumes that the pages are standard and that the response requirements and evaluations within each work-book are identical for each learner. In the Vineland system previously described, recorded responses are made by each child

on each of the work-book pages. The total number of responses per work-book is available as are individual attendance records; thus, it can and is possible, using the work-book completion dates, to make means, variances, correlations, etc., based on rate per hour scores against such factors as sex, age, socio-economic level, etc. This writer feels that changes in rate of response to work-book pages (rather than absolute rate) will probably emerge as the most sensitive response rate measure. Analyses should also reflect the initial objectives of the project; simple plots can determine trends for each learner and the class as a whole.

Verbal Interaction: The measurement of social-interaction, if that is a relevant variable in the system, can be performed readily by setting up forms to determine: (1) the number of times and by whom responses are initiated within a given period of time; and, (2) who is the recipient of the response (a) another learner (b) the teacher (c) the teacher aide, or (d) the parent-aide. Carefully collected time samples of such class-room interaction patterns can generate a broad range of scores, such as:

(1) Number of responses initiated by learners, teachers, and aides per hour.

(2) Number of responses received by learners, teachers and aides per hour.

(3) The ratio of learner to adult response

  (a) initiations

  (b) the ratio of learner to adult responses received.

(4) The number and length of "chained" responses. (A response chain is defined as possessing at least three elements, initiation-reception and a response back to the initiation (I-R-I). The frequency of chained responses between learners and between learners and adults is readily obtainable).

This type of measure clarifies who is initiating responses and who is reacting to them. In a pre-school learning system based on higher learner response rates, a teacher whose response rate is very high (above 45%) is reducing the level of responsivity for all learners in her class-room; the response opportunities for perhaps 25 children are limited to 55% of the available time. If ten observations are taken per week on a random basis, social interaction measures are readily obtained which permit the analysis of ratios of learner initiation to adult initiations; learner reception to adult receptions; learner initiations to adult receptions; learner receptions to adult initiations, etc. The number of "chaining" responses among learners and between learners and adults also would be of value. A chained response involves comprehension and attention to the language of another, ability to respond in a pertinent and meaningful way to the information received, incorporation of the new informational element fed back, and the response in the new enriched context. Growth in the size and number of chained responses in a pre-school setting could be a significant index of growth in social interaction skills.

Verbal-interaction scores can be computed by learner class and for all learners and staff and are useful as a basis for staff discussions because they provide unambiguous evidence. Though the form should be used anonymously in staff meetings, teachers quickly use the form operationally and limit their responses where they see themselves as initiating a high proportion of responses.

The Critical Social Incident: Where a learning system specifies as an objective the improvement of social skills, a quantitative method for determining the effectiveness of procedures related to improvement of social skills should be an organic aspect of system operation.

The measurement method should involve an unambiguous specification of behaviors defined as anti-social. These specified anti-social behaviors may be modifiable in terms

of experience in operating the prototype system but a clear listing of such behaviors is necessary to define this particular system objective and to minimize differences in teacher reactions to similar behaviors. When such behaviors occur, the system procedures (1) should involve whatever system method is employed to deal with it and (2) require a record covering the date, child, and perhaps the anti-social behavioral element itself. If a card or form is completed for each learner activity specified within the listed domain, then it becomes possible to establish the initial anti-social base-line for each child, each class, and the system as a whole. Curves can be drawn to establish whether learner anti-social behaviors are decreasing, maintaining their own level, or increasing. Anti-social behavioral rates can be obtained and these, in turn, can be related to workbook response rates, teacher ratings, absenteeism, etc. Difference scores indicating drop-off in anti-social behaviors could, in turn, be related to IQ shift, Peabody scores or other indices using correlation and analysis of variance techniques.

Absenteeism: Absenteeism may be viewed as a social index; however, absentee scores should be separated into successive and intermittent patterns. Successive scores indicating the presence of a childhood illness should be discarded. The greater the social involvement in the learning system, the higher the threshold for a non-attendance response. Absenteeism should be viewed as an index of total family involvement. Absentee scores, totalled on a quarterly basis, can be used as successive scores over time for individual children, classes, and the system as a whole. Difference in scores by individual learners could be analyzed against difference scores in number of anti-social incidents. Workbook progress rate, language and performance scores also could be analyzed against absentee scores.

The Home and Community as Diagnostic Resources: Institutional systems readily produce conforming behaviors in many instances. The learning system for pre-school children must be judged, not only on how well the children perform when their behavioral expectations are known, but also, and perhaps more importantly on how well they use what they have learned when all response options are open.

The effects of a learning system can only be partially assessed in the classroom. The development of measures for obtaining evidence of system effectiveness involves decisions as to the most valuable kind of diagnostic information. In this analysis, major emphasis should be given to determining whether the prototype learning system has sufficient force to generalize beyond its own limits or whether it merely produces conforming behaviors within its own walls. Evaluations of performance and the impact of the system on the learner should extend beyond the institutional capsule itself, to the family and community setting which are vital dimensions of analysis of the value of the system for the learner.

With this purpose in mind, major emphasis should be given to evaluating the objectives of the learning system as reflected in the child's behavior in the home and community. Dimensions which merit analysis are: Differences in the system educated child as compared with siblings given alternate methods of training with reference to: (a) vocabulary; (b) level of aggression; (c) impulsivity; (d) avoidance and withdrawal behaviors; (e) social interaction as evidenced by cooperativeness, empathy, sharing of toys, books, candy, and other goal objects; (f) relationship with parents; (g) general position of peer group as peacemaker, leader, follower, etc.; and, (h) types of activities characteristic of behavior in and out of home, etc.

The data gathering methods for external generalization measures could consist of: (1) structured interviews;

(2) rating scales; (3) ranking methods; (4) critical incidents; (5) behavioral sampling; (6) in-depth observation, etc. An estimate of the generalization vector beyond the learning system is essential if we are to determine whether the prototype is producing mere conformity or assisting learners to cope with the problem solving, adjustment and social-interaction processes of life itself.

There has been considerable controversy over the use of IQ tests and other measures of language and performance which favor children from specific socioeconomic, cultural and ethnic backgrounds. In this writer's view, the suggestion that any test of verbal or performance skill is somehow tapping genetic potential involves the erection of a Mendelian metaphysics on a psychometric altar. Tests which involve making choices as to the meanings of terms and following directions will, if scored correctly, give an advantage in score to children who possess the greatest reservoir of meaningful terms in the language of the test and who comprehend and are willing to follow directions precisely. Capability to make certain classes of important meaningful response choices is, in fact, being measured. Genetics are irrelevant to the item structure, the responses made, the scoring, and the computation of the IQ score itself. The gratuitous assumption that the gene pool is being tapped should be relegated to the same forum which now serves those who debated the number of angels who could dance on the head of a pin.

Binet and Simon's early statement on the value of the IQ still appears reasonable to this writer. It is a direct and immediate measure which produces a score on the "present moment" which reflects comprehension, judgment, reasoning and invention.

> ...In order to recognize the inferior states of intelligence we believe that three different methods should be employed. We have arrived at this synthetic view only after many years of research, but we are now certain that each of these methods renders some service. These methods are:

1. The medical method, which aims to appreciate the anatomical, physiological, and pathological signs of inferior intelligence.

2. The pedagogical method, which aims to judge of the intelligence according to the sum of acquired knowledge.

3. The psychological method, which makes direct observations and measurements of the degree of intelligence.

From what has gone before it is easy to see the value of each of these methods. The medical method is indirect because it conjectures the mental from the physical. The pedagogical method is more direct; but the psychological is the most direct of all because it aims to measure the state of the intelligence as it is at the present moment. It does this by experiments which oblige the subject to make an effort which shows his capability in the way of comprehension, judgment, reasoning, and invention. (Binet and Simon, 1961; p. 883).

Do the standard IQ tests have a function for the measurement of pre-schoolers or are they useless because the IQ notion has been a device to suggest the necessary ascendancy of a meritocracy, destined by Mendelian imperatives, to leadership over those who couldn't come up with as many correct responses. In this writer's view, these scales have functional value for producing useful evidence as to the value of a learning system. These reasons are as valid now as when Binet presented the first tests in 1911 (incidentally without suggesting a genetic rationale).

The IQ tests present a standard and limited universe of items which predict with some success how well children can perform within certain institutional settings. Binet's institutionalized language pattern, standard reading matter, and standard recitation methods involved a centralized school system with a national curriculum, standardized teacher behaviors, recitation methods and student response requirements. Although our educational system lacks the orthodoxy and centralization that characterized France at the beginning of this century, language and behavioral expectancies, nevertheless, are sufficiently homogenous to make the IQ score extremely useful. Irrespective of the magical genetic claims, the IQ scores are good predictors of school success. Therefore, systems involved in getting children ready to attend elementary school will find them useful. If the mean IQ level of pre-school children in a learning system is initially below 75 but has risen to 100 or more after two years, the gain is important. One can predict that a substantially greater percentage of these children will survive the first grade public school environment because they have the language base, ability to attend to directions given by an adult, and the willingness to respond to an adult without resistance.

The Evaluation of the Individual Performer

In evaluating any human performance, there are a few basic conditions which must exist for the measuring instruments to have value. Human measures must be related to some dimension which increases in magnitude as a function of the human performance dimension being tested. One method of attaining this dimensionality is to set up a pot-pourri of items, obtain inter-correlations, and assign dimensions on the basis of factor loadings. Another is to construct the test items along a given dimension such as vocabulary,

reading comprehension, arithmetic, grammar or other achievement area. Such tests may be useful as indicators of individual performance levels under certain conditions, for example:

(1) Instances where items are not taught in the classroom overtly or covertly or are not known by the teacher so that scores on the test reflect a true sample of the relative performance level of the learners.

(2) Instances where tests are equally fair to all respondents and maintain dimensional integrity; for example, a test of reading should not require imformation known to some but not all respondents since this confounds reading scores with an information base. Readers who lack the information will obtain scores which cannot be differentiated from (a) non-readers with the information; and (b) non-readers lacking the information.

(3) Instances where guessing scores and zero response scores have the same value. An examinee who does not respond on an initial text and guesses on a second version of the same scale should not be assured of a gain on the second measure as his knowledge or skill level was not shifted.

(4) Tests in which the scales do not generate score differences as a consequence of age, sex, color, dialect, or any factor other than the dimension of measure.

(5) Settings where test directions are not used to shape score distributions, since skills in accepting directions are not relevant to the dimension being measured

unless the scale is a measure of skills in following directions.

(6) Situations where notation is made that failure to score well on a test is due to (a) emotional factors (b) illness and/or (c) resistance to the tester.

(7) Tests in which item correctness is absolute and not based on the relative frequency of high scorers. The latter criterion begs the question of the standard by shifting it back to the learners themselves behind a statistical mask. By the same token, item correctness should not reflect beliefs, customs, language, or accepted truths at particular socioeconomic levels or be related to geographic usage.

Any factor which clouds the value of the score as an indicator of the learner's true performance level should be accounted for. Though psychological scales are generally barred from cardinality, every performance score should be reflected by an ordinal number which is indicative of the capability of the examinee along the dimension being tested. Non-performance should be labelled as such and not exist as hidden error within a statistical analysis.

The preceding criteria for measurement of individual learner performance would screen out widely used achievement tests. These tests are not suited to the measurement of individuals but are useful tools (under some conditions) for making comparisons of different groups of learners. However, even here, these shot-gun tests have dubious value for evaluating learning systems.

These venerable tests initially had a different function than they now serve, namely to provide estimates of the level of mastery of content areas within standard curricula.

However, these tests have become so popular that much of the class-work is now directed to teaching informational elements which tend to crop up within the tests. In many cases, these tests do not sample learner skill levels across curricula but function as measures of teacher and student sagacity and commitment to locating and/or predicting the kind of information which will be covered.

Under these circumstances, though the initial forces for these tests have maintained their momentum, the tests have lost their raison d'etre. They no longer measure what they were designed to measure. More important, they have reduced much class-room teaching to informational splinters, test related fragments which sharply limit student opportunities to integrate and conceptualize relationships within curricular areas.

Or stated more directly, much teaching does not involve the total curriculum, but test preparation. Although the educational measurement problem cannot be dealt with at length here, it should be evident that serious efforts to improve our educational system through the use of learning systems must also focus on the development of stronger measurement tools than those now in popular use. Until then, decisions on the relative merits of alternative learning systems (including pre-schools) cannot be made with any great confidence.

In this analysis, learning system evaluation hinges on five basic factors:

(1) Learner Gain Measures: The difference in total capabilities of learners as measured at the point of entry into the learning system (base-line scores) with their total capabilities on leaving the system (out-put scores).

(2) Generalizability Measures: The degree to which the learning system succeeded in providing adaptive and socially useful skills when transferred to the home and community.

(3) Value for the Next Life Stage: The degree to which graduates from one school level (e.g. pre-school) are able to adapt and perform effectively in the next life stage. From the entry level, follow-up studies are necessary to determine the value of pre-school learning systems as related to impact on elementary, adolescent and adult performance in school settings and in the community.

(4) Cost of pre-schooling per learner in relationship to gains in performance: A system which produces substantial gains in four areas is four times more efficient per dollar expended than a system which produces like gains in only one area.

(5) Gains attributable to the learning system in terms of savings in tax dollars: These could be related to drop-off in special education programs, vandalism, drop-out, welfare, medical costs, incarceration, parole costs, etc., as a function of more adequate pre-elementary school readiness. Using extended longitudinal studies, pay back for pre-school systems could be related to tax yield differences across pre-school learners as compared with non-pre-school trained children and differences across children given different types of pre-elementary school readiness training.

(6) Analyses across pre-school systems to compare their relative level of efficiency in assuming elementary school readiness: Such analyses should be made within the first month in first grade.

The major danger in requiring that learning systems be locked into theoretical frameworks is that easily manipulated micro-theories would have an immense advantage which would sharply limit the range, depth and scope of class-room learning systems. Theoretical tunnels could reduce pre-school systems to magnified laboratory settings focused on very narrow (but measurable) responses. The essence of the pre-school classroom must be the organic growth of the total human being.

It is imperative that theories be developed which can deal with the problem of an ever-evolving learner. Eclecticism is preferable to the erection of theoretical barriers which limit the rate, depth, and extent of learner development. Learning systems must be gauged by learner output performance: however, where usable within a pre-school, and across the range of skill development required the system should be tested and articulated.

Measuring Learning Process: The measurement of individual performance within a learning system is viewed, in this analysis, as one means of determining the efficiency of the system in process. One can estimate system efficiency through measurements of changes in learner performance over time as related to costs in personnel, materials, equipment and facilities. The measures of the learning system as a process of obtaining changes in performance over time involve such dimensions as:

(1) Rate, depth and extent of learning language skills and content information.

(2) Control over impulse and aggression, general life adjustment in the school, home and community setting.

(3) Social value of the learning system in terms of adjustment, adaptability, awareness,

and interaction with others of differing ages, sexes, colors, socioeconomic status, language, etc.

(4) Ability to work independently (or as a team member or team leader) to determine objectives and to work effectively and solve intermediate problems to achieve objectives.

(5) Ability to solve problems to attain goals in non-standard, idiosyncratic, and creative ways.

(6) Ability to move into new situations and adapt, perform, and meet the standards required.

(7) Ethical and moral understanding involving the rights of others and the obligation of the self to others.

The Measurement and Comparison

Total Learning Systems: The measurement of learning systems by IQ measures, available achievement tests, rating scales, the use of authority, theoretical conformity, or conformance with accepted dogmas offers little basis for decision among alternative approaches. Achievement tests have been devised (and used by the writer) which purport to measure at the pre-school level. The fact that widespread achievement testing produces item teaching class-rooms is now an accepted fact of American education. Learning systems at the pre-school level should involve the use of measures which are categorized as follows:

(1) Impervious to Inflation Criterion: Are unable to be taught in the class-room as a means of inflating scores.

(2) The Synthetic Criterion: Function to develop skills in integrating and organizing information for purposes of problem solving and goal achievement.

(3) The Total Child Criterion: Go far beyond the limitations of content information and relate to total personality integration and life adjustment.

(4) The Future Value Criterion: Function as learning systems in terms of overall impact in later life performance.

Learning systems for the young will be, in this analysis, the most important determinant of the quality of the future national manpower base. If this assumption holds to any significant extent, the measurement of pre-school learning systems should be so organized as to provide national policy makers with absolute and incontrovertible evidence of the relative merits of the alternatives which now exist and which will emerge in the future. Decisions so vital to the society as a whole merit the development of measures which function to insulate decision makers from exaggerated claims, class-room gimmickry, and well organized marketing strategies. The essence of the problem is to develop a battery of pre-school measurements which: (1) function to measure system out-put based on learner performance; and, (2) are used within an organizational network which insures the validity of the evidence.

One requirement in the area of systems measurement is to move beyond standard tests to evaluate individuals and pretend that combined individual scores permit evaluations of systems, not collections of individuals measured on a limited subset of discrete items within a given curricular area.

The following analysis assumes that (1) the use of pre-printed standard achievement tests erode and limit teaching and learning in the class-room and (2) offers substantial

advantages and great temptation to systems builders to insure that test item-related materials are completely covered within the learning systems. This could well mean that a weak learning system which heavily focused on test items would appear to have higher output scores than a substantially stronger system which covered the total curriculum plus various life related skills.

The suggested method of testing and evaluation of preschool children which follows is general and is assumed to cover content, social-interaction, general performance, problem solving, generalization to home and community, follow-up tests, etc. The presentation here is necessarily abbreviated but hopefully the coverage will be sufficient to indicate the general point of view to those concerned with the system measurement problem.

For purposes of illustration we will consider a content area within the system containing: (1) 15 major concepts; (2) 35 sub-concepts which are linked in various ways to the 15 major concepts; and (3) 200 relationships involving definitions, inter-relationships, and functions.

For purposes of illustration: (1) these three patterns form the total universe of information in the given content area; and (2) the inter-relationships to be covered among the three patterns is limited and consists of 1000 informational elements. These 1000 informational elements which are by definition non-redundant are then used to generate 1000 items. Of course, this informational base could be used to produce two, three or more, items per element, but no such item redundancy will be assumed here for purposes of simplicity.

The next step would be to: (1) store the 1000 items into a computer with a print-out capability; and (2) program the computer to randomly sample across items and print out tests, consisting of, say, 100 items each. Thus each test would contain a sample of ten percent of the total item population. But as the items would be drawn at random, each

learner would have his own unique ten percent sample of the total universe of content information covered in the curriculum. If the computer were to print out 1000 tests, there would be 100,000 items. Each of the 1000 learning elements in the system would occur 100 times, by chance, across all tests generated.

Without considering problems of test administration -- which are not relevant at this point -- we may move quickly to the data collection process. For purposes of simplicity, we will test 1000 learners across six pre-school learning systems (A,B,C,D,E and F). On entering into a given learning system each learner would be given a base-line test covering the content area. Each learner would be tested on his unique sample of 100 items, and would respond to his unique combination of items. However, all learners taken together would cover the total universe of items in the curriculum and each item would occur equally often for each system being tested.

Though no single individual would be required to respond to more than a small fraction of the curriculum, the total curriculum would be covered 100 times over by the learners in each of the set systems. The effectiveness of each learning system would involve the degree to which the universe of information (or behaviors) had been learned across the sample of learners covering the population of information in the curriculum. Rather than testing individuals on repeated sub-samples of the curriculum, samples of individuals would be used to determine degree of mastery of the total population of information in the curriculum. Statistical methods could be used to evaluate item difficulty, reliability, internal validity, etc.

However, because the emphasis in this approach would be on the ability of the system to produce a total learning product, there would be room for many types of analysis which are not now part of the psychometric armamentarium.

In this context, means, variances, difficulty indices, score-ranges, distribution-shapes, median mean relationships,

etc., become diagnostic tools for improvement of the learning system. For example, large variances indicate that a system distributes scores at the extremes and delivers inadequate support for "weak" learners; high item difficulty indices would pinpoint areas of weak coverage in the learning and/or evaluation aspects of the system, etc.

Table 3 on the following page presents a hypothetical outcome of the scoring of the 1000 learners in the six systems previously mentioned. These hypothetical tests are viewed as occurring over a period of 24 months. During this period each learner was tested six times in each system. Each learner, of each system presumably received a different test for a total of 36,000 different tests. If we assume that the tests would be reasonably reliable (above .90, Spearman Brown), there can be no argument about validity as items are drawn directly out of the curriculum itself.

An examination of Table 3 will be used to indicate the writer's view of how this universal sampling method could be employed as a decision making tool:

(1) System E started with learners with a minimal content base (Mean 18.3) which almost doubled during the course of the two year period (gain = 18.2). Of special note was the accelerating rate of increase over time.

(2) System D which started at the highest level in terms of content managed to obtain a substantial increase: (12.7) points with the rate of gain maintained throughout.

(3) System F, which had the next to the lowest rank in base line scores appeared to offer very high acceleration at the outset through Interim Test #3 but reversed slightly (falling down from 39.8 to 38.9) on Interim Test #4 and gained slightly for the final test. Its output difference of +16.9 was second in rank order

Table 3

Mean Performance on Six Hypothetical Learning Systems

A, B, C, D, E and F

Total Curricular Universe Test

	N	Base Line Test	Interim #1	Interim #2	Interim #3	Interim #4	Post #5	System Output Differences
System A	1000	37.2	37.8	41.3	42.5	42.6	42.7	+ 5.5
System B	1000	28.3	31.4	34.3	36.7	38.3	39.2	+ 10.9
System C	1000	41.5	42.3	43.2	42.8	43.6	44.7	+ 3.2
System D	1000	44.6	46.3	49.2	53.2	55.4	57.3	+ 12.7
System E	1000	18.3	18.6	18.9	23.4	29.8	36.5	+ 18.2
System F	1000	23.2	28.5	34.6	39.8	38.9	40.1	+ 16.9
Total Means of Systems	6000	32.18	34.15	36.91	39.73	41.43	43.41	

Table 3; A hypothetical array of means from six learning systems based on six total universe curricular 24 month period.

for the systems, though clearly the system as designed lacks momentum for the full two years in this content area.

(4) System A, which was slow at the start, managed to generate a reasonable gain between Interim Test #1 and Interim Test #2 but remained quite static thereafter.

(5) System B, starting with learners in the mid-range of base-line scores, managed to make quite respectable gains (+10.9) but was de-celerating by the time of post-testing.

(6) System C showed very little gain (+3.2) over the 24 month period, beginning with a rather knowledgeable group of children. Though some gain occurred at each test point, there is little evidence that the system has substantial value in this content area.

Table 3 offers several decision points:

(1) Check available data for Systems A and B to determine whether minimal end-product yields occur across all curricular components.

(2) Determine whether staffing, staff training, equipment, materials and facilities handicap actual testing of the method.

(3) If methods are functioning as planned, then system personnel and leadership should be informed that their systems are functioning in a marginal range and will be discontinued unless system outputs move above, say, a 10.0 range over the twenty four month test period.

If we assume that the data in this curricular area reflect the entire range of test scores across all test areas then:

(1) Systems E and F should be tested with children in the mid and high range to determine whether they can maintain their acceleration rate with higher base-line children.

(2) System D should be tested on lower base-line children to determine whether the method would have a greater rate of acceleration on the assumption that learning growth rates decelerate as a function of preceding learning growth.

Table 3 could of course be subjected to an analysis of variance using difference scores as covariance (based on the base-line sources). Correlational matrices are readily developed across successive tests. Without belaboring the point, standard statistical tests to test the null hypothesis (single tailed and two tailed tests) appear to offer no greater difficulty using these measures than currently used measures. The problem is to develop researchable learning system models which encourage sophisticated decision making based on careful research.

The tests given to measure a learning system should of course be (1) specific to the stated objectives of the system and (2) reflect the growth of the child across all dimensions (such as those listed in the 12 points below).

The total system test concept, as viewed by this writer, does not include the type of factual punctate elements now used in the typical multiple choice test. Essentially test items are viewed as demanding problem solving skills. The brief test descriptions below are suggestive of the kind of test considered appropriate to evaluate total learning systems.

The completion and testing of measures for total learning systems will involve considerable effort which will be justified if education can finally begin to make rational decisions as to the best method or system necessary to attain learner behaviors over an extended period of time.

For purposes of clarifying the differences between current measures and measures of the total learner, a few alternative dimensions will be listed which could be developed into measures to assess total system effectiveness:

(1) A test of comprehension skills covering language, gesture and expression.

(2) A test of understanding of the functional relationships of objects taken singly and in combination.

(3) A test of ability to analyze and organize information where all necessary information and/or equipment is supplied within the item itself; however, one important condition is that no information from the home, community or class-room can form the basis for an adequate response.

(4) A test of creativity in which all items in the test have a conventional means of achieving a solution to a problem covering a sequence of steps. Creative scores occur when (a) new solutions are produced using an alternate sequence or (b) a solution is obtained in fewer steps.

(5) A test of social-interaction skills which involves two or more persons to solve any given problem. Solutions occur best under conditions where children communicate and are aware of each other's activities and work to cue each other's responses to attain their mutual objective.

(6) Test of control over aggression and impulse in which problems are designed so that it is always possible for one child to obtain a goal or prize for himself. However, if he works with one or more children the same prize goes

to each participant. The scores are based on the choices made (social vs. antisocial) and the kinds of behavior patterns exhibited.

(7) Assessment of task involvement where tasks are developed which require large numbers of responses over extended time periods to reach some pre-established goal. The learner is scored on the basis of the number of responses made to each goal-task and the shape of the response curve over time. This could be an important index of motivation.

(8) Measurement of stimulus generalization to determine the degree of distortion made by the learner in responding to very similar but differing stimuli. This could be a useful index of anxiety and uncertainty.

(9) Learning effectiveness measures to cover a variety of learning problems that may develop but have a standard difficulty level. Learning Effectiveness Score would be based on the rate at which material was learned. This scale, though admittedly posing some problems, would be of major importance if a valid and reliable method were to be developed. Positive shifts in learning system would require correlations with gains in performance within the system to establish validity.

(10) Learning system tests which measure understanding of complex conceptual relationships (while providing objectivity). These are not beyond reasonable limits of attainment.

(11) Past-Future Tests which would be concerned with whether the learner prefers the safety of

past situations which are totally known or future situations which involve uncertainty, risk and opportunity.

(12) The Verbal Chain Test which involves the number of times the child can maintain verbal interactions with another child or adult on a given subject where all information is known and distractions are present at intervals.

The development of suitable performance tests to evaluate total systems would be an interesting, even challenging exercise. It would of course be expensive, time consuming and result in some new problems statistically. However, from this writer's perspective, none of the available tests (including his own) are suited to the problems involved in comparing total learning systems that have been designed to improve the development of our young people for tommorrow. It should be emphasized that a new method would not exclude use of all standard measurement techniques although ingenuity and flexibility would be required in devising others. Without a carefully organized measurement system, such as suggested, learning system decisions can be based on gross but unreliable score differences, powerful and authoritative voices of support, conventionality and theoretical conformism. The problem is not to obtain system endorsement nor even an articulate and enthusiastic system constituency. The problem reduces to the use of objective measurement to determine, as realistically and objectively as possible, the systems which are most effective in terms of the development of the child as a whole, intellectually, socially and emotionally.

AN EDUCATIONAL RESEARCH SUPERSTRUCTURE

The problems of educational research are not soluble by the researcher regardless of the adequacy of his theory or his operational system. Education is a pervasive social institution which affects every level of society. Educational research, therefore, deals with the very marrow of our social system, and the destiny and the opportunity of all our children. The educational researcher cannot anticipate the neat and ordered simplicities of the laboratory. He is dealing with other people's children and public money and the success or failure of his method is of interest to appointed and elected public officials of every level. The educational researcher is a man whose work is under public surveillance in a far more intimate way than the physicist, psychologist, or engineer.

Experimental research is one of the methods men use to select the best among many possible alternatives. More explicitly, research is a complex decision-making tool which men must employ when logic, authority, divination, and traditional beliefs have proven powerless.

There are many euphemisms used to convey the notion that experimental research is now being accomplished in education. "Evaluations by experts" -- a standard technique used to judge the worth of a project -- ultimately assures that traditional views are crystallized and supported by current research. "Educational innovation" is often interpreted as a variation of an accepted method or belief which has managed to gather a large number of enthusiastic adherents.

The student of physics and the student of education, at the undergraduate and graduate level, are each studying methods, procedures, and measurement instruments but the differences in their experiences are profound. The physics student is learning material which is consistent with the underlying theoretical system which has a demonstrated efficiency in controlling and predicting events, whereas the

education student has no such rigorous and systematic conceptual spine upon which to rely. Consequently, the graduate physicist can move boldly into designing devices (e.g., cyclotrons, radar, spectrometers, etc.) with confidence borne of experience that the energy and costs involved will be justified. In education, the converse holds; in the absence of a cohesive and established theoretical base, educational methods are tentative and uncertain; movement into novelty involves career risks and the educational researcher often retreats into minor modifications of conventional and admittedly inefficient methods to avoid stepping off into a conceptual abyss unsupported by a network of theory.

For present purposes, an educational project exists, when, and only when, there is a comparison among alternative treatments to determine the method of greatest value in terms of student learning. As research in physics involves the investigation of the physical properties within space and time, educational research is limited to the investigation of methods to improve learning capabilities within well defined learning environments.

Educational research involves the interaction of a complex chain of interacting variables within a confined space such as the classroom, language lab, lecture hall, seminar or pre-school. The physical space controls the limits of mobility and visibility and audibility of stimuli; the classroom equipment (desks, chairs, teaching machines, etc.) controls pupil distance, social interaction potential and verbalization opportunities, etc.; floor covering differences affect the impact of noise level, as well as visual and tactile stimulation; and, walls affect sound and may be blank or be covered by a barrage of confusing, attention gathering stimuli. Generally, the time consumed by teacher activities largely controls the amount of time available for responses by all learners. Further, the emotional state projected by the teacher is reflected in the emotional reaction by all learners, and perhaps also in satisfaction, apprehension and/or frustration.

Sensitivity to differences in language and behavior as a function of economic level, race or ethnic origin, also can profoundly affect learning rates. In addition to the above sample of factors which may affect the learner's ability to comprehend printed materials and verbal statements, there are factors such as family preparation, learner health, nutrition, self image, community attitudes, etc., which may add to the variables which interact in the classroom context.

In short, the classroom or learning environment is a complex network of interacting variables which produces a product or resultant change in student performance abilities. The degree to which these interacting variables are interrelated to predict outcomes is the measure of the quality of a learning system. The classroom then is viewed as a learning system, which has as its single and unvarying objective, the improvement of the learner's range of abilities. Restated, Educational Research is the systematic effort to improve the classroom as a learning system for the purpose of increasing student adjustment, knowledge and performance. This definition of educational research is not consistent with much of the wide range of work which is now termed (and supported) under the rubric of educational research.

In the present analysis, educational research differs from psychological research in that it is directed toward improving the rate and quality of human learning in a social situation (the classroom), a phenomenon which involves the use of independent but interacting variables. In psychological research in learning, however, variables are isolated to the degree possible (so as not to be confounded) and the operation usually involves one isolated variable on one subject, human or infra-human, at a time. Psychological research certainly can contribute important data to educational research; however, it is important that the limits of each research area be clearly designated, that a sharp and unremitting focus be maintained to minimize confusion across these behavioral areas which differ in theory, technique, method and objectives where learning processes are involved.

Research Dynamics:

A simplified diagrammatic illustration of research dynamics is presented as Figure 7; The Lattice of Research Relationships. In the lower left hand cell (Cell A-1), the term Problems in Nature is used to indicate the area of investigation. In the area of bio-chemistry, Nature would, of course, relate to the requirements and interactions involved in living organisms, in physics, the boundaries would cover matter from the subatomic to the galactic, including pertinent time and space relationships. In the present context, this would be the total classroom ecology, ranging from a student and teacher on opposite ends of a log, to complex electronic classrooms and/or life simulation classroom models.

The next cells (A-2, A-3) cover the body of assumptions used to control and predict Nature. For over two centuries, man predicted natural events in the heavens and on earth, largely through the use of imaginative use of Newton's three Laws of Motion, which proved instrumental in many ways. However, Einstein's modifications of Newton's analyses predicted somewhat different outcomes of similar phenomena. These two overlapping but partially contradictory networks of assumed relationships or theories predicted different outcomes under certain definable conditions which we need not elaborate upon here. Viewing these relationships in light of Figure 7, however, one can see that when predictions (A-3) are made from two consistent theories (B-2), then a test situation is constructed (A-4) which ideally is designed as a fulcrum which must tip in the direction of one theory or the other (D-4). As an integral part of the experimental design, a measurement system (A-5) must be used which measures with sufficient sensitivity, reliability, and relevancy to insure that any true differences will be accurately and repeatedly obtained. Once the measurements are obtained (D-5), they are subjected to a statistical analysis (A-6) to simplify and compress the mass of data and also to give some estimate of the probability that one theoretical position has merit over the other (F-6). However, as

The Lattice of Research Relationships

FIGURE VII

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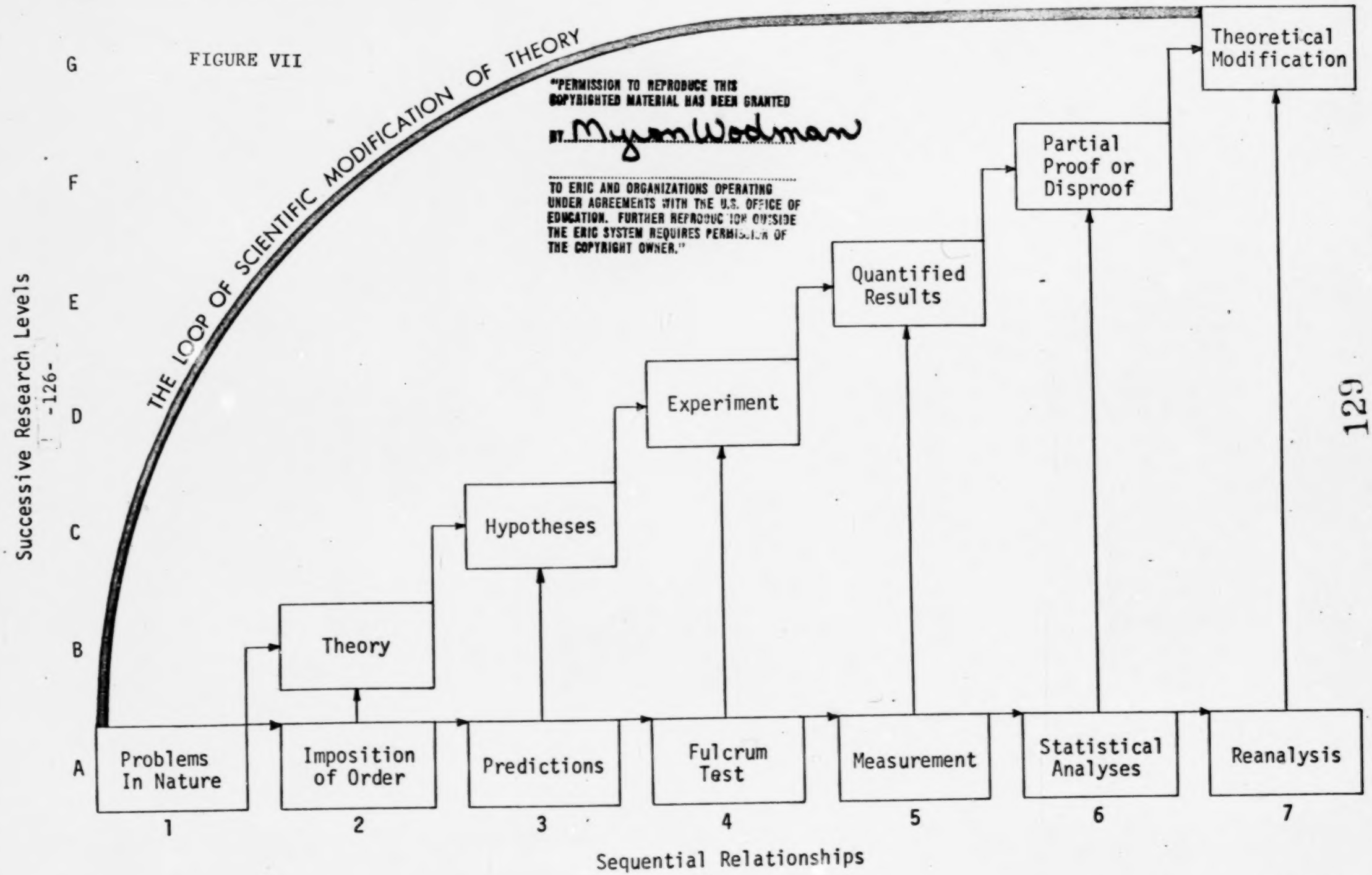

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all theories are in the process of evolution, even the prediction of the correct theory would still be in error to some extent, and of course the weaker theory which had lost the Fulcrum Test would be in still greater error. Based on the new data from the experiment, theoreticians from both competing positions, would evolve new frameworks for their assumptions (B-2). Again points are located where theoretical differences are sharp and differing hypotheses can be tested against each other; a tiny sliver of Nature is carefully tested and measured to determine which theory holds best for the given test, and once the data is in, new theoretical images are constructed. Each pattern of modification increases the level of theoretical precision and increases the scope, value and precision of the theory. As the research scientists increase their ability to predict and control Nature, so does the society. Ever evolving precision in theory translates to an ever greater control over Nature.

Nature in educational research is, of course, the learning context or the classroom as a learning system. The fundamental research problem is to develop a set of assumptions (A-2) which forms a theoretical network (B-2) with sufficient power to develop a set of predictions or hypotheses (C-3) which can be tested under controlled conditions (A-4) and under circumstances which permit the acceptance or rejection of the hypotheses which we term The Experimental Test Situation (D-4).

Theory A: A learning context will be most efficient if based on the following assumptions:

(1) The environment is enriched and provides an ever changing field of stimulation using selected learning materials.

(2) Learners are always given total freedom of choice.

(3) A skilled teacher operates as the basic source of information and is responsible to inspire and motivate learners.

(4) Periodic testing generates student motivation and involvement.

Learners self-actualize themselves in environments which provide the following basic developmental ingredients.

Theory B might offer an alternative or overlapping set of assumptions, such as:

(1) Learning systems involve control over choices.

(2) The number of choices offered to the learner will be small at the outset and increase gradually based on demonstrated mastery.

(3) Motivation to perform will occur best when the classroom operates as a social system which is neither autocratic nor anarchic, but where status gain and social roles are outcomes of demonstrated proficiency.

(4) Learning is optimized under conditions of maximal responsivity by the learners and minimal intrusion by adults.

(5) Learners will develop highly socialized behavior under conditions where no learner can succeed at the expense of failure by another.

(6) Language learning in the classroom context will occur optimally to the extent that terms improve the ability of the learner to function on word-related tasks.

(7) The classroom itself should be designed as an ecological space which provides structured, orderly and predictable relationships and also provides unstructured space for free and expressive behaviors.

(8) The teacher's role should be essentially that of an orchestrator of materials, movement and pattern of interaction of learners and evaluator.

(9) Impulsive, aggressive, and other disorderly and/or disruptive behaviors are best handled by providing opportunities for these behaviors to occur under conditions where they are not followed by either reward or punishment, but only by an effectively neutral time gap.

(10) The quality of a learning system is validated by learner performance in the next life stage.

These two theoretical systems may then be tested experimentally by carefully planning the classroom's organization and learning materials to conform as closely to the theoretical models as possible. Children of equivalent initial performance capability (by appropriate measures) would be retested to determine rate of gain. Also, measures would be made of ability to adjust and perform in the next life stage and thereafter. The two theoretical models should be studied closely to determine points where predicable differences can be developed into hypotheses.

It is immediately apparent that Theory B predicts a higher learning rate of skills, greater social skill development, higher motivation to perform, and greater control over impulsive and aggressive behaviors, as well as improved self-expressive capabilities. Hypotheses would then be developed, based on the theories predicting the outcome given the correctness of Theory A, and an alternative set of predictions for Theory B. Within this framework, one might test the following, as possible hypotheses:

(1) The Language Learning Hypothesis:

> Treatment B learners will have greater language skills as measured by tests of verbal comprehension, speech, reading, and writing than Treatment A learners.

(2) The Social Interaction Hypothesis:

> Treatment B learners will inter-relate with each other and with adults better than Treatment A learners as measured by teacher and parent ratings, and sociometric tests.

(3) The Behavioral Control Hypothesis:

> Treatment B learners will have greater control over impulsive and aggressive behavior in free and unrepressed situations than Treatment A learners, as measured by behavior samples in free play situations.

(4) The Motivational Hypothesis:

> Treatment B learners will tend to require less adult control, initiate a

greater proportion of responses, and respond more interactively with each other, as measured be behavioral samples, than will Treatment A learners.

(5) Post-System Performance:

Learners given Treatment B in a pre-school setting will perform more adequately in the elementary school setting, including first grade, than learners given Treatment A, as measured by grades, classroom performance, tests of achievement, attendance and disciplinary reports.

A system test, such as the one sketched out above, may be possible once our educational research posture shifts to evaluating learner performance outcomes under carefully organized conditions over extended periods of time. The consequences of such a comparison, under appropriate test conditions, could have a massive impact, not only on pre-school learning systems, but education as a whole.

The Replicability Problem:

If a pre-school learning system were to be supported by research findings over a number of years, it would still require three additional basic characteristics to be of practical value as an instrument for improving educational quality at a national level. These characteristics are: (1) the range of utility; (2) standard; and, (3) exportability. By range of utility, I mean that it should be usable by as many different kinds of learners as possible; it should span different ages, socioeconomic levels, urban-rural boundaries, ethnic and racial differences, and, of course, it should work for both sexes. By standard, I mean that the system should

require little or no modification when it moves from the research and field setting to general adoption by school systems in locales with responsibilities for children differing in factors such as socioeconomic level, background, speech, and systems of values. By exportable, I mean that the experimental system should be sufficiently well articulated so that each of the system elements (equipment, learning materials, teacher training, system administration, evaluation, etc.) should exist in a form which permits rapid digestion and utilization by a new school system. Three months after acceptance of the new method, effective classroom operation (including teacher training) should indicate whether the system is exportable.

However, a proven research project which is public, standard and exportable will still fail, unless it is palatable to all persons concerned with the system in any way. Thus, new research systems, as part of the export process, require orientation preparation and public awareness in each new community setting, or their very novelty can become a basis for community controversy and jeopardize their acceptance.

Obtaining Evidence to Education Decisions:

Educational research differs in quality and kind from the physical sciences as well as the behavioral and social science activities which can take place in neatly controlled settings, such as the psychological laboratory, or in descriptive field studies characteristic of anthropology and sociology. Education takes place in the life cockpit of its activities, directly affects the family and is pervasive for the community. The educational research realities not only differ in method, but in the process of performing the research; the new method must be acceptable to the community and to the families involved, or it will fail to survive the time frame required to determine its value.

In addition, if we consider the problems faced by a hypothetical educational researcher who has evolved a theory from which a prototype educational system could be built,

we may be able to point up some of the key issues for testing the efficacy of a system which differs radically from existing systems. Such an undertaking would require:

(1) Money for the materials, equipment, teacher training, etc.

(2) A setting providing conditions where a true test could be made.

(3) Training and continual upgrading of teachers and staff to insure conformity to the method.

(4) Freedom from requirements to meet local, state and federal administrative regulations which violate system requirements.

(5) Capability to involve parents, professional and civic organizations as required to insure understanding and community support for the project.

(6) Pre-test and interim test capability to establish the rate and quality of system performance.

(7) Capability to employ experts for advice, suggestions and coordinated effort where required to solve problems.

(8) Powerful and immediate public support for research freedom when and if a project came under attack from the press, or any other powerful force.

These eight points, though helpful to the individual researcher, would not provide the basis for determining which of a number of alternative systems was more efficient in

terms of learner performance, cost, effectiveness, long-range impact at the elementary school, high school and adult levels. Historically, research in education, because of its community nature, high costs, crucial importance to the individual, and vital manpower implications for the society as a whole, is vulnerable to social pressures. It is no accident that Socrates, an educational innovator of considerable merit, was viewed by many as undermining the social system because he attempted to break through certain conventional beliefs with a technology which required the learner to make choices among carefully framed alternatives.

The development of effective learning systems for our children will require, in this writer's view, an apparatus which is specifically designed to continuously improve available systems, and a means to facilitate the dissolution of inadequate systems, while insuring support for those which improve learner performance capabilities.

The crystallized attitudes engendered within these powerfully emplaced educational fortresses have been neatly pinpointed by Silberman in a discussion of individually programmed instruction involving the view of James Becker, Director of Research for Better Schools (RBS) in Philadelphia. Silberman states:

> . . .'IPI's strategy assumes that the ends are known, that somebody does in fact prescribe the goals, and that a student is supposed to reach those carefully defined goals. Indeed, it is a highly structured kind of strategy.' Becker concedes that 'some concepts of individualization of instruction at some times in some subject areas might include ends that the student himself defines.' For himself, however, the concept is clear: '<u>I must reject the idea that maximum freedom is a necessary condition for something called individualization of instruction</u>.'

> Few educators, however, would pose the alternatives in such stark terms: total prescription of goals by others, or total freedom for the student to pursue his own goals. Indeed, Becker's definition of the alternatives represents a complete misunderstanding of the nature of education and a perversion of its goals. (Silberman; 1970, p. 199; emphasis added).

The essence of research is that it must be tested on the basis of objective evidence. There is, and should be, no advocacy or fossilized belief. When a research organization can assert imperatives behind a screen of research objectivity, the term research is reduced to a travesty. As long as educational research organizations can pre-determine a "best solution" without conclusive evidence, and then proceed to use their resources for expansion, defense and advocacy, research in education is reduced to a travesty. In a later section of this paper, it is suggested that funding of research programs, evaluation, and report writing be organized as separate functions. Further, it is held that such evaluations be directed to comparing alternative learning methods to obtain evidence as to (1) which produces the greatest learning gain and (2) how various approaches can be improved. This is important as the educational research labs may reject methods of possible value in pursuit of some idee fixe.

THE EDUCATIONAL RESEARCH TESTING SYSTEM

The Decision Making Apparatus

The research of an individual in education has extremely limited value, even when its implications are substantial. This is partly due to the number of competing forces, complex and overlapping agencies, and restrictions of funds, time and personnel. However, even when substantial resources have been made available for Community Action Programs, Regional Educational Laboratories, and Manpower Programs, the results have failed to strike sparks. Adherents of various fashionable approaches advocate panaceas.

Ungraded schools, total elimination of literary, exotic computerized hardware, and Educational Television are currently vying for adherents. The fact is that classroom learning whether graded or ungraded, using books or machines, requires that certain contingencies occur. Machines are neither good nor bad qua machines. The issue is one of deciding whether one approach or another produces greater yield at less cost in time, personnel and dollars than another.

Education must move beyond advocacy and test methods in its own crucible--the classroom. Evidence as to learning system effectiveness should not force organizations to: (1) develop research programs; (2) design the measuring instruments for the evaluation; (3) obtain the evaluation data; and (4) write research reports which support or reject their programs.

These are public organizations whose functions are primarily defensive. They are focused on: (1) funding for the following year; (2) justification of their line of effort; (3) avoidance of conflict with key local, state, and federal figures whose support is required to maintain and/or expand the level of effort; (4) minimizing repercussions in the media which might damage their image; and,

(5) attempting to maximize and justify their organizations' efforts through formal and informal contacts, and effective use of media.

The foregoing statements are not criticisms of educational laboratories, but reflect the fact that their functions are not primarily concerned with educational research, but with the maintenance and expansion of their organizations under extremely difficult conditions. Research projects are, by definition, unpredictable and in the context of the laboratory structure, this can be very threatening. In lieu of research, the labs set up broad contacts with school systems, hold conferences, evaluate and consult with school systems on community problems, help schools fund and install fashionable approaches involving the use of programmed materials, and hardware. The fact is that educational research, as used in this paper, is too controversial for the labs to handle.

The small sampling of defensive maneuvers merely indicates that the structure of the mission at the educational research labs forces certain patterns of defense. The comments are illustrative and are not to be construed as a criticism of any particular agency which spends funds in initiating evaluation and reporting its own work. Rather, it is intended to stress the fact that any agency which acts to initiate, put into action, and evaluate, is taking over three tasks which are similar to those which this government initially divided among the legislative, executive and judicial branches.

By this time the dynamics of decision making in educational research should be clear. There should be no system protagonists who evaluate and recommend for or against their own work. Further, those who take the responsibility to fund learning systems should have no responsibilities for evaluation, field testing or later report writing. Those who initiate and design systems should be free to evaluate their systems in the interest of optimizing their functional value in terms of learner performance, and to write research reports, perfect their

theoretical position, methods, materials, etc; however, internal research reports should not be the basis for major policy decisions. Rather, decision making should involve comparisons across real (rather than written systems) and involve an organization limited to this particular responsibility.

In the area of pre-school education, it is suggested that there be a carefully articulated structure specifically designed to designate those learning systems which produce the greatest gains for children at every level. Also, this structure would ban all recommendations on hard data and would report directly to the highest official in the agency. The first element (Pre-School Program Acquisition and Support, termed PPAS) in this decision structure would be two functions:

(1) Support, fund, and foster large scale and realistic research efforts over extended time periods;

(2) Insure that research projects once undertaken would not fall victim to administrative cross-currents and shifts in political viewpoints but continue as planned.

PPAS should, in short, act only to provide the stability necessary to explore the adequacy of a particular theoretical approach when it is put into practice in a reasonable test setting. A research support staff would, on request, iron out and prevent difficulties which could jeopardize the project and/or consume excessive amounts of professional time, such as outside assaults on the system. They would represent the system in such cases and thus, provide the necessary time to obtain the data that would be required to accept or reject the innovative method on the basis of obtained data.

PPAS would make available at the request of the research teams, programmers, statisticians, computer services, and consultants so that large masses of data could thus be reduced

into manageable statistical statement.

Thus, PPAS is viewed as offering optimal benefits where:

(1) It functions to assist in research planning if and when required.

(2) It helps locate the optimal conditions for the test of the theoretical position and related operational system.

(3) It protects the integrity of the project from dilution as a consequence of administrative and/or political intrusions.

(4) It aids project personnel, where requested, to help insure community support by orientation of professionals, community leaders (formal and informal), parents and various community groups.

(5) It provides resource consultants, where requested, to assist in further articulation of the theoretical model, data analysis, computer programming, computer availability, and analysis of the statistical data obtained.

(6) Using ERIC and other information banks, PPAS provides articles and analyses as requested by project personnel to assist in theory construction and report writing, to minimize project myopia.

As is evident, PPAS is viewed here as a device to support and strengthen project operation. It functions to offset the fundamental vulnerability of educational research projects to whatever chance winds blow at the community, state or even the federal level. PPAS is viewed as a much needed protagonist and supporter of the educational researcher to assist him in solving problems and obtaining technical support as required.

It may be viewed as a home office, ever ready to assist and support the men and women in the field with personnel skilled and trained to help keep educational research projects from being inundated by forces beyond the limits of project control. PPAS's mission is to attempt to insure, using all available resources, that a learning system, selected for test, does in fact get the time and resources required to be tested fairly and without prejudice.

Evaluating the Learning Systems

PPAS has been viewed as the home base and windbreaker for researchers in educational systems. It would provide the prestige, power and resources of the federal government and insure adequate tests of educational systems. However, the very involvement of PPAS in the funding and support of its various projects is a barrier which effectively compromises objective evaluation of its projects. For this aspect of the educational research effort, a separate and independent apparatus is a necessity or PPAS will be in that ancient federal trap with two jaws: (1) rejection of projects it has put money into, or (2) self-congratulation where projects are hailed as successful under the suspicion that trap #2 is always superior to #1 whatever the data.

The PPAS apparatus would be monitored out of the office of the Director who would insure that:

(1) PPAS maintains complete compliance with initial regulations;

(2) PPAS is modified to improve capability to select and support learning systems;

(3) Reports on funded projects are evaluated independent of PPAS and based on objective data using the best available analytic techniques.

For this purpose, it would be necessary to form a second organization such as Learning Systems (ERLS), which would also report to the Director. This organization (ERLS) would be a completely separate monitoring group, located in a different city, and would have no contact with PPAS other than notification of the funding of the proposal. ERLS would be specifically barred from performing educational research of any kind. It would have no authority, directly or indirectly, (by regulation) to assist or support educational research projects in any way and would have no relationship, formal or informal, with PPAS. Rather, its functions would be to:

(1) Analyze the basic theoretical position advanced in the proposal and various project related papers, and analyze the operational system to determine degree of conformity with the theoretical structure.

(2) Generate its own data (designing the necessary evaluation tools where required) to improve its ability to evaluate projects. This would be simplified by the fact that it would have complete access to all project data.

Evaluation by one group over another's efforts implies power to support or to destroy. Also, all evaluations contain error and bias. ERLS will have its own biases and errors formed out of the mission and the professional histories of the men and women who carry it out. The alternative to imprecise evaluation is no evaluation. To insure that ERLS errors will be correctable and occur within certain pre-specified limits, the following type of guidelines should be rigorously written into the regulations, to insure that ERLS operates to facilitate pre-school learning system development and does not use its evaluation authority to destroy projects which happen to violate current thinking:

(1) All evaluation instruments, data collection, analysis methods, and reports will be made

public and routinely supplied to the Director, project personnel and any other educational and research organizations which may request them.

(2) All procedures, criteria, scoring methods, weighting techniques, etc., used in a data analysis as well as all reports involving total project evaluation, will be made public and routinely supplied to the Director and to the experimental project.

(3) ERLS would be responsible for developing and testing new measures, including total system measurement methods to facilitate realistic measurement of pre-school learning systems. It would compare the relative effectiveness of alternative systems to determine the degree to which each system was optimizing the child's total performance.

A third group, independent of PPAS and ERLS, would be responsible for evaluating and comparing all projects funded by PPAS. This agency, termed for convenience as the Learning Systems Agency (LSA), would obtain the evaluations supplied to the Director by ERLS, through its own resources, and from the project itself. Its function would be limited to producing evidence for decision. It would:

(1) Evaluate the programs supported by PPAS in terms of theory, philosophy, level of articulation of methods, limits of objectives, short and long range implications, etc.

(2) Evaluate the merits of the measuring instruments and methods developed by ERLS.

(3) Make statistical analyses across learning systems with similar objectives to determine the most effective system.

(4) Write reports to the Director responsible for determining which pre-school learning systems are most effective in process and over extended time frames.

(5) Make recommendations to the Director for expansion and/or limitation of given learning systems.

(6) Indicate the criteria required for more effective evaluations by ERLS.

LSA would have one sharply defined mission; the determination of efficient learning systems based on evidence. The systems covered would be limited to those sponsored by PPAS and evaluated by ERLS. LSA would be barred by regulation from evaluating either PPAS or ERLS. Although LSA would have all available evidence on a large number of systems, this evidence would be focused on only one objective: to inform the Director, as unambiguously as possible, of which learning systems were offering the greatest benefits to American pre-school children.

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